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SCIENCE

25 December 1959

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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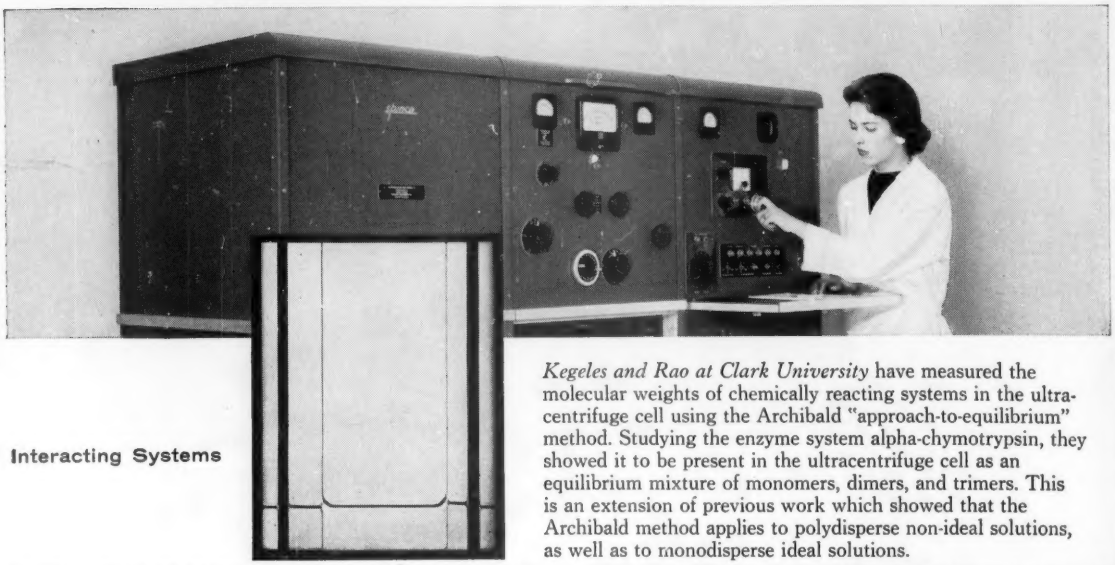
Index Issue

New Methods Extend the Usefulness of the Ultracentrifuge

Recent studies by research scientists have further increased the uses of the Analytical Ultracentrifuge for measuring molecular weights and purity of viruses, enzymes, proteins, polymers and a variety of organic and inorganic molecules. Here are four new developments as reported in the technical literature.



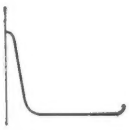
Interacting Systems

Kegeles and Rao at Clark University have measured the molecular weights of chemically reacting systems in the ultracentrifuge cell using the Archibald "approach-to-equilibrium" method. Studying the enzyme system alpha-chymotrypsin, they showed it to be present in the ultracentrifuge cell as an equilibrium mixture of monomers, dimers, and trimers. This is an extension of previous work which showed that the Archibald method applies to polydisperse non-ideal solutions, as well as to monodisperse ideal solutions.

Improved Accuracy

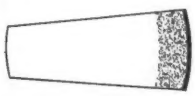
Trautman, at New York's Rockefeller Institute for Medical Research, showed that the accuracy of the Archibald method can be improved by more precisely locating the position of the meniscus on the ultracentrifuge photographic plate. He made a detailed study of the optical fine structure at the meniscus, and used a special optical aligning procedure with a mirror in the ultracentrifuge cell.

Simplified Measurements

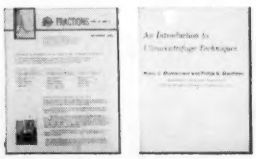


At Stockholm's Nobel Medical Institute, Ehrenberg reports a simplified approach-to-equilibrium method which makes measurements from the schlieren curve easier. He runs the ultracentrifuge fast enough for a peak to begin forming at the meniscus so that the schlieren curve is parallel with the baseline and no extrapolation is necessary. His measurements of molecular weight and diffusion constants agree closely with those by other methods.

Rapid Equilibrium



Van Holde and Baldwin at the University of Wisconsin have used short liquid columns to achieve complete sedimentation equilibrium in a fraction of the time previously required. Using liquid columns of only 3 mm, they report equilibrium with sucrose in 3½ hours, and with a 1 mm column in only 30 minutes. In addition, the authors report that measurements during approach-to-equilibrium permit calculation of a diffusion coefficient.



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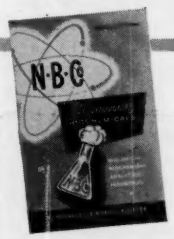

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Letters

Psychosocial Synthesis

If the allegations contained in Margaret Mead's letter in a recent issue of *Science* [**129**, 1514 (1959)] are true, then I and all those with whom I worked and who reviewed my contribution are very deluded people.

There was no technique for any psychosocial synthesis in 1938. There were only exhortations to find one. There were Lamarckians like Freud and Roheim who were seeking universals and survivals, like castration and Oedipus complexes. Others mentioned by Mead were deriving the character of modern man from anal erotism (Fromm).

What I described in *The Individual and His Society* was a technique and not an ideology. It could only have been conceived by one who knew enough about psychodynamics to identify what personality traits were derived from what specific cultural directives. This belongs to a school of psychodynamics known as *adaptational*, which in 1938 was just arising. It does not follow Freud's libido theory, which bypassed the cultural variable and could not include it in the frame of reference.

The anthropologists with whom I worked would not have permitted their names to be used in an endeavor based on a technique plagiarized from others. Linton and Du Bois kept me well informed about what was being done by other anthropologists. Sapir and Benedict participated in these early seminars. There were most interesting ideas, but there was no psychodynamic technique.

I do not know what is meant by "historical parallelism." The most charitable interpretation is that at the time such a technique was "in the air." It was indeed; but it has been there since Herodotus. If my work was just a coincidence, why did Mead abandon the culture pattern for the genetic study of character in Bali, and Benedict adopt it whole for the study of Japanese character? The basic principles for this technique were worked out on Marquesan and Tanalan cultures. The technique was reinforced by Du Bois and me in 1939–1940, in the study of Alor. Mead and Bateson discussed this latter work at my invitation publicly in 1942. I then heard no untoward insinuations about this technique.

In a recent survey (1955) of *Psychoanalytic Schools of Thought*, a disinterested writer, Ruth L. Munroe, spends much time on my contribution, but she fails to pick up either the plagiarism or the historical parallelism. Munroe shows a thorough acquaintance with those whom Mead alleges to have been my original sources. The only one who invented the tools that I used was Freud, even though he did not use them as I did.

In any case, I request that Mead expose me, not by decree or innuendo, but by documentation. This will require finding a technique (meaning a procedure, based on demonstrable principles, not an ideology, or intention of finding a procedure) that was in existence before 1938 and that could perform the following: derive the personality formation specific to each culture without the aid of the libido theory; demonstrate the relation of this personality to the adaptational problems of the community as a whole; demonstrate the relation of the products of fantasy to this personality; demonstrate the relation of child-rearing practices to the development of affectivity; demonstrate the relation of this latter development to the devices the society has for maintaining intrasocial balance and demonstrate criteria for intrasocial imbalance; and, finally, demonstrate the use of psychoanalytically oriented biographies as a source of information about the impact of social directives on personality formation and have these results check with projective tests like the Rorschach.

A. KARDINER
Department of Psychiatry, Emory University, Emory University, Georgia

Kardiner's letter is in response to my comment [*Science* **129**, 1514 (1959)] made in reply to the review [*Science* **129**, 322 (1959)] by Julian H. Steward of my volume on Ruth Benedict, that "at the time that Abram Kardiner independently began to apply psychoanalytic theory to the study of culture, the major theoretical lines for the study of personality and culture . . . had already been worked out. . . ." His response illustrates a dilemma that is widespread in those areas in which clinicians and research scientists attempt cooperation. The clinician, tied to his consulting room, with limited time for reading and usually none for field work, is often compelled to reinvent the known in his search for the unknown. This inevitably leads to a sense of having initiated *de novo* a whole field which may have existed for years. When I added to my comment the statement that "I have always regarded Kardiner's work as an example of historical parallelism," I was reasserting my belief that he did develop his approach independently. Such "parallelism" is the exact opposite of plagiarism.

In 1941, at Kardiner's express re-

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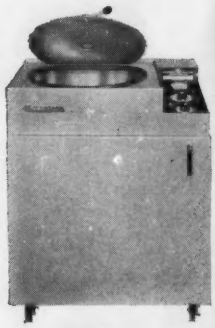

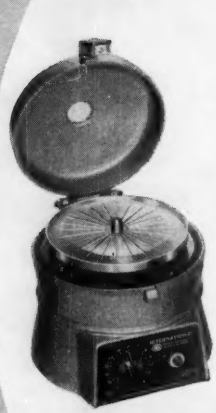

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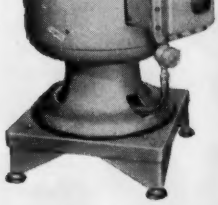

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Letters

(Continued from page 1728)

quest I wrote a considered evaluation of his book, *The Individual and His Society*, for the *American Journal of Orthopsychiatry* [**11**, 603 (1949)]. At that time I characterized his method as unique in that "Dr. Kardiner has exposed himself to auditory experience [that is, listening to the accounts presented verbally by anthropologists] of the integrated set of social institutions which make up a culture." In the same review I commented also that Kardiner had undertaken "the ambitious task of developing a social science *de novo* with no original data of his own and without an explicit reliance upon other workers —an ambition which is very much tempered in his own field by an explicit utilization of the work of Freud himself, and Fromm, Horney, Rado and Reik." When I undertook to write this review, I specified that a parallel evaluation of the book must be requested from a psychoanalyst and Sandor Lorand's review appeared in the same issue [*Am. J. Orthopsychiat.* **11**, 605 (1949)]. After commenting on the psychoanalytic theory, Lorand expressed the hope that "the anthropological data . . . may stimulate anthropologists to recognize the importance of cooperation between psychoanalysis and anthropology." This it did, and anthropologists should be grateful to the very substantial stimulation and backing which Kardiner gave to several important pieces of field work, particularly the work of Cora Du Bois.

I do not now—as I did not in 1941—make any attempt to evaluate Kardiner's contribution to psychoanalytic theory (it was for this reason that I stipulated that a review of *The Individual and His Society* by a psychoanalyst should be included). I speak only of that body of theory known as "culture and personality," which Lawrence K. Frank must be credited with having initiated in the 1920's. The first published use of the *phrase* that I know of was by the anthropologist Leslie White, in 1925, in his article, "Personality and culture" [*The Open Court* **39**, 145 (1925)].

In the folder which contains my manuscript of the review published in the *Journal of Orthopsychiatry*, I find a page originally designed as a footnote but not published with the review. I reproduce it here, as it was written in 1941—so much closer to the events in question.

This review will be confined to a consideration of the first part of Dr. Kardiner's book, that which concerns itself specifically with cross-cultural problems as the book falls into almost distinct sections, with the latter of which only a practicing analyst is fully competent to deal.

This is the most ambitious attempt to rear a purely theoretical structure of the inter-relationships between the socialization of the child and the overt cultural forms, within the framework of psychoanalytic theory based upon experience in analyzing adults. During the last fifteen years there has been increasing attention devoted to this problem and it has been attacked from several different angles, by an adult analyst with anthropological training who went into the field and applied anthropological and ethnological methods in the field (Roheim), by child analysts working in cooperation with analytically trained anthropologists (Erikson, working among the Sioux in cooperation with Scudder Mekeel, and among the Yurok in cooperation with Kroeber; Levy, working within a cultural context which was being studied by J. Mirsky), by psychoanalysts working out of the field upon material collected in the field by a psychologically oriented field worker (Spitz analyzing Mead), by a psychoanalyst analyzing ethnological material which contained formal material on children (E. Jones on Malinowski), and by field workers who have taken into the field a psychological orientation and [have] applied it specifically to the study of children (Mead, Gorer, Henry, Bunzel, the Beagleholes, Whiting). In all of the instances cited the concrete material has involved direct observations upon children collected with direct reference to the problem of character formation. During the same period there has been an increasing amount of theoretical writing upon the problem of personality and culture which made certain very definite assumptions about the importance of the socialization process, although it did not use data based on the study of children (notably Benedict, Sapir, Frank, Sullivan, Lasswell, Dollard, Bateson, Horney, Fromm, Hallowell). . . .

Kardiner's second claim—that in response to his work, initiated in 1938, I abandoned the "culture pattern" approach in my work on Bali (which, incidentally, was planned in 1933–1934) for "the genetic study of character"—shows the same profound lack of knowledge of my published work which makes me feel quite safe in acclaiming his independence of the published work of his predecessors and contemporaries. I began using the "genetic study of character" in my first field work in 1925, and before the Balinese work was planned this approach had been progressively systematized in cooperation with other workers in the field. Notable among these were Lawrence K. Frank, who in the early 1930's inaugurated a cross-cultural study of this type at Yale under Edward Sapir and John Dollard; Erik Erikson, whose systematic specifications of developmental stages were already available; and Erich Fromm, who was relating economic behavior and character structure.

Ruth Benedict's inclusion of some child-rearing material in *The Chrysanthemum and the Sword* (1946) dates back to her slowly growing recognition of the importance of this approach through her participation, in 1936, in the National Research Council Committee on Psychological Leads in Field Work (which was chaired by Edward Sapir, and for which Geoffrey Gorer worked on the background material) and also to the work on Japanese character done at the beginning of World War II by Gorer, Gregory Bateson, Clyde Kluckhohn, Alexander Leighton, myself, and others.

In his letter, Kardiner invokes Ruth Munroe, the author of *Schools of Psychoanalytic Thought*. In this book (page 141), Munroe writes: "She [Ruth Benedict] *taught* Kardiner, Mead and others in their earlier approaches to this problem." Ruth Benedict and Ruth Bunzel both participated in the seminar organized by Kardiner in 1936, to which Cora Du Bois and Ralph Linton later contributed.

The *techniques* which Kardiner claims and which he illustrates through reference to Du Bois' work—that is, the use of life histories, projective tests, children's drawings, myths, and observations on child-rearing practices—had all been developed before 1938.

MARGARET MEAD
American Museum of Natural History, New York, New York

Bibliography

R. Benedict, "Anthropology and the abnormal," *J. Gen. Psychol.* **10**, 59 (1934).
———, "Continuities and discontinuities in cultural conditioning," *Psychiatry* **1**, 161 (1938).
J. Dollard, *Criteria for the Life History* (Yale Univ. Press, New Haven, Conn., 1935).
E. H. Erikson, "Observations on Sioux education," *Am. J. Psychol.* **7**, 101 (1939).
G. Gorer, *Hot Strip Tease and Other Notes on American Culture* (Cresset, London, 1937).
———, *Himalayan Village* (Joseph, London, 1938).
E. Homburger (E. H. Erikson), "Configurations in play—clinical notes," *Psychoanalytic Quart.* **6**, 139 (1937).
D. Levy, "Sibling rivalry: Studies in children of primitive groups," *Am. J. Orthopsychiat.* **9**, 203 (1939).
M. Mead, *Coming of Age in Samoa* (Morrow, New York, 1928).
———, "An ethnologist's footnote to *Totem and Taboo*," *Psychoanalytic Rev.* **17**, 297 (1930).
———, "The primitive child," in *Handbook of Child Psychology*, C. Murchison, Ed. (Clark Univ. Press, Worcester, Mass., 1931), pp. 669-687.
———, review of G. Roheim, *The Riddle of the Sphinx*, in *Character and Personality* **4**, 85 (1935).
———, "On the institutionalized role of women and character formation," *Z. Sozialforsch.* **5**, 69 (1936).
———, Ed., *Cooperation and Competition among Primitive Peoples* (McGraw-Hill, New York, 1937).
J. Plant, *Personality and the Culture Pattern* (Commonwealth Fund, New York, 1937).
G. Roheim, "The psychoanalysis of primitive cultural types," *Intern. J. Psychoanalysis* **13**, 1 (1932).
E. Sapir, "The emergence of the concept of personality in a study of cultures," *J. Social Psychol.* **5**, 408 (1934).
R. A. Spitz, "Fruehkindliches Erleben und der Erwachsenenkultur bei dem Primitiven; Bemerkungen zu Margaret Mead *Growing Up in New Guinea*," *Imago* **21**, 367 (1935).

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Next Question

For several years radio astronomers have been speculating about the existence of intelligent beings in the "radio" stage of civilization in planetary systems other than our own. As G. Cocconi and P. Morrison pointed out in *Nature* (19 September 1959), no theories yet exist which make possible "a reliable estimate of the probabilities of (1) planet formation; (2) origin of life; (3) evolution of societies possessing advanced scientific capabilities." Current astronomical theory suggests that planetary systems may be the rule rather than the exception in the universe. If this should be so, then there is a certain incalculable probability that x planets suitable for the evolution of living beings exist, and that on some of these, living beings may not only have evolved but have become highly intelligent.

Cocconi and Morrison assume that "To the beings of such a society, our Sun must appear as a likely site for the evolution of a new society. It is highly probable that for a long time they will have been expecting the development of science near the Sun. We shall assume that long ago they established a channel of communication . . . and that they look forward patiently to the answering signals from the Sun which would make known to them that a new society has entered the community of intelligence."

On the assumption that it is worth a try, even though the chance of success is extremely slight, early next year a small part of the operating time of the 85-foot telescope at the National Radio Astronomy Observatory at Greenbank, W. Va., will be devoted to a systematic search. The program is described by the director of the project, Frank D. Drake, in the January 1960 issue of *Sky and Telescope* (published 21 Dec. 1959). The most promising frequencies for exploration would be from 1000 to 10,000 megacycles per second. Within this range, Drake thinks (in agreement with Cocconi and Morrison), any being attempting interstellar communication would select the hydrogen line—a frequency at which radio telescopes would be operated most intensively anywhere in the galaxy during the early developmental phase of radio astronomy. The signals would presumably be confined to a narrow band width (the narrower the band width the greater the range) and should show a varying Doppler shift, since the source would be in orbit. The instrument will first be focused on Tau Ceti and Epsilon Eridani, sun-type stars about 11 light-years away.

What kind of signals might we expect? Radio astronomers agree that pulses to communicate prime numbers or some simple arithmetical problems might be suitable. A more sophisticated possibility would be, as Drake has suggested privately, for the "others" to send out pulses in clusters—a series of pulses followed by a pause, another series, another pause, and so on. The number of signals in each pulse could stand for intensity of light or dark, and we could build up a picture on the basis of the information received.

A final consideration remains. We must in addition assume that the intelligent beings with their highly developed radio technology have developed a kind of interstellar Point Four program for underdeveloped planets and that they are willing to devote a considerable effort to maintaining a long-term program of beaming messages to our hitherto unresponsive system.

Consider our own program. If you ask radio astronomers why we ourselves don't start to broadcast, you learn that they think the fiscal authorities would not approve. This leads to an unhappy thought: May not other civilizations (if they exist) have evolved analogous fiscal authorities? And may they not likewise be waiting in silence for our signal before they give their response?—G.DuS.

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25 December 1959, Volume 130, Number 3391 **SCIENCE**

Migration and Speciation in Newts

An embryologist turns naturalist and conducts field experiments on homing behavior and speciation in newts.

Victor C. Twitty

I have chosen to deal in this article with the subject that is of most interest to me personally—namely, the working relationship I have enjoyed for over twenty-five years with my favorite animals, the newts of California. When I first went to Stanford University in the early thirties and began what I thought was the hopeless task of finding an adequate substitute in the West for the classical *Amblystoma punctatum* that was the mainstay of experimental morphologists in the eastern United States, I stumbled across three or four new species and subspecies of the California newt in the course of collecting material for embryological studies from various parts of the state. And the work that I have done since then has been largely shaped by the amphibian friendships I formed at that time. Having discovered these new species, and given them names (it was someone else, however, who named one subspecies *twittyi*—later declared invalid!), I have developed a proprietary interest, and maybe a feeling of obligation to them, that has influenced my choice of experiments ever since, including some that are quite far afield from my original interest and training.

The author is on the staff of the department of biological sciences of Stanford University, Stanford, Calif. This article is adapted from a presidential address delivered before the American Society of Zoologists at the 1959 meetings held at Pennsylvania State University, University Park, Pa.

As a student of Ross G. Harrison, I was of course at the time looking for things that I could get my iridectomy scissors into, and the first thing that struck me was the markedly different pigment patterns that distinguished the larvae of the species of California newts.

The neural-crest origin of the pigment cells was just in the process of being established at that time by DuShane, and as a confirmed heteroplastic grafter it was inevitable that I would soon begin switching neural crest and related tissues back and forth between the embryos of the species; by this method, and also through the use of tissue culture, I was able eventually to analyze in considerable detail the developmental basis of the hereditary differences in pigment patterns. This led in turn to studies on the problem of cell migration per se, and if I were writing this article five or six years ago it would undoubtedly deal with cell patterns or cell movements, or some other related embryological topic.

But in the meantime my interest has been diverted to other aspects of the biology of California newts, and instead of dealing with the movements of salamander cells, this account will deal mostly with the migrations of the adult newts themselves. This may seem to be a surprising transfer of emphasis, but from the time I first came to know these animals and began to experiment with their embryos, certain collateral questions arose that have continued to intrigue me. For example, I had learned shortly after discovery of the species that artificially produced hybrids were completely viable, but at the time methods had not been developed for rearing California newts, whether normal or hybrid, to maturity in the laboratory, and so I did not know whether the hybrids were fertile. Also, in working out the life histories of the different species I became aware of some interesting differences in their behavior. For example, one species would lay its eggs singly, another in flat clusters, another in round clusters; one would choose quiet water for spawning, another rapid mountain streams; and so on. To make a long story short, I had always wanted to undertake some experiments—merely as a sideline, I thought at the time—to learn whether artificially produced hybrids would grow to maturity if released in nature, and if so, whether they would be fertile—would perhaps even interbreed with the native parental populations, with all of the interesting possibilities that that would present—and also to learn how hybridization might affect some of the behavioral differences I have mentioned.

An opportunity to test these somewhat visionary questions came in 1953 when I obtained permission from the owners to establish a field station on a large ranch in the coastal mountains of Sonoma County about 100 miles north of San Francisco (*1*). Western newts require four or five years to reach sexual maturity, and needless to say the answers to the questions will be slow in coming. The last couple of years we have begun to get some very encouraging results, however, and later I shall indicate briefly where we stand.

But it is principally some of the unexpected by-products of the project with which I should like to deal at present.

Migration Studies

When we began planting young hybrids in a selected experimental stream on the ranch, the alarming thought struck us that even if the hybrids did survive to maturity they might scatter

over the whole countryside and eventually select for breeding an entirely different stream—maybe in the next county.

And so we were immediately faced with the question: Do newts have a fixed home range throughout their lives, or are their yearly movements to and from the water of a random nature, perhaps carrying them to new breeding sites each year? I had never anticipated that I would become involved in such unfamiliar issues as this, but I can say that the study of the problem has been just as fascinating—and just as involved and difficult—as the study of the migrations of salamander cells.

And so, as briefly as possible, let me outline what we have learned and what remains to be learned.

Taricha rivularis (*2*) is the species that is most abundant at the ranch, and is the one that we have used for the migration studies. *Taricha granulosa* is also present there, but in much smaller populations. The other two forms, *T. torosa* and *T. t. sierrae*, are native to other regions of the state. In one part or another of California, *T. granulosa* is sympatric with the other three forms, but the latter are not known to be sympatric with one another.

There are several streams on the ranch, but we have selected for our work one that is called Pepperwood Creek, a tributary of the Wheatfield Fork of the Gualala River. Pepperwood Creek is a small stream, but it is literally crawling with newts during the breeding season. To give you some idea of the size of the population we are working with, I might mention that since the project began we have, by systematic collecting, removed from a 1½-mile stretch of this stream—the portion we have set aside for our studies—a total of over 24,000 females, partly for use in the hybridization experiments. That is a lot of "waterdogs," as they are called in California. The effects of this inroad on the size and on the sex ratio of the *rivularis* population is an incidental problem of considerable interest in itself, and one that we are following in some detail.

Figure 1, a contour map prepared from a U.S. Forest Service aerial photograph, shows the course of the experimental stream and the topography of the adjoining terrain. For recording our results, the portion of the stream selected for the study was marked off into a series of 58 "stations" or intervals, each 50 yards in length and identified by numerals painted on trees or boulders along the stream.

The great majority of the population inhabits the mountainous and heavily wooded slope to the south, and from here each spring the newts descend to the stream for breeding. At the end of the mating season they leave the water abruptly and redistribute themselves over the mountainside, where they spend the dry summer months underground.

When the rains begin in the autumn or winter the animals emerge again and forage on the forest floor, often high upon the mountainside. Since the ter-

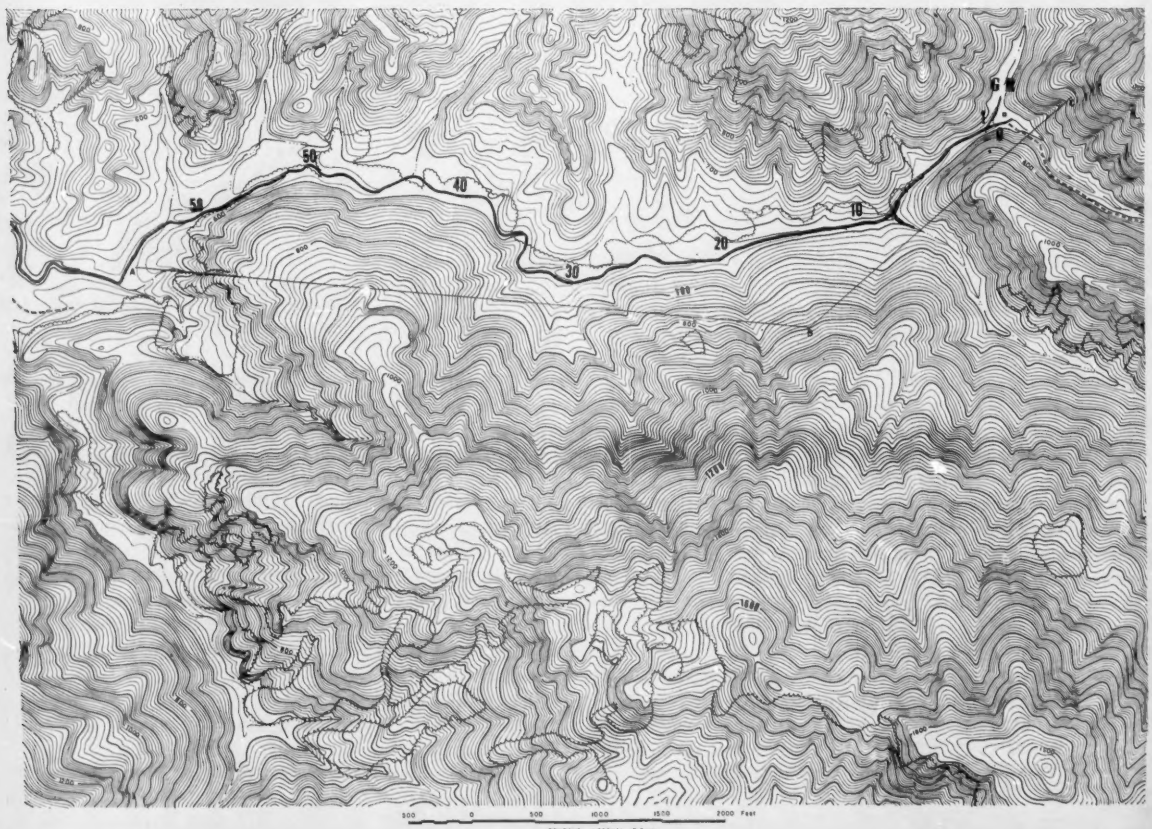


Fig. 1. Contour map prepared from a U.S. Forest Service aerial photograph, showing the experimental stream and the topography of the adjoining terrain. Each spring newts descend to the stream for breeding, primarily from the mountainous slope to the south.

rain they traverse in returning to the stream as the breeding season approaches is very rugged and irregular, cut by many gullies and ravines, one wonders whether a given animal returns to the same segment of stream where it had bred the year before, or whether it is perhaps diverted to a new point of entry. In other words, are we dealing in this study with a single, shifting population within which there is relatively free mixing and interbreeding of individuals throughout the experimental area, or is it perhaps instead a more or less stable mosaic of relatively isolated subpopulations, each with its own "home area" and restricted segment of the experimental stretch, to which the same group of individuals returns year after year for mating and reproduction?

To find the answer we have marked literally thousands of animals for subsequent recognition, and I shall cite the results of only a few representative series.

In 1953 we collected 262 males from a single pool at station 9, marked them, and returned them to the same pool. The first observations on this series were made two years later, and observations have been made each year subsequently (Fig. 2). As you will note, year after year virtually all of the animals recaptured were taken at or very near the pool where they were originally collected and marked. This was as true this past season, after six years, as it was in the beginning. The percentage of recaptures has also been high, over 60 percent the first year and still about 40 percent this last year. (In fact, a total of 85 percent has been recaptured over the years, but never that many during any single season.) Incidentally, this speaks for the longevity of the species

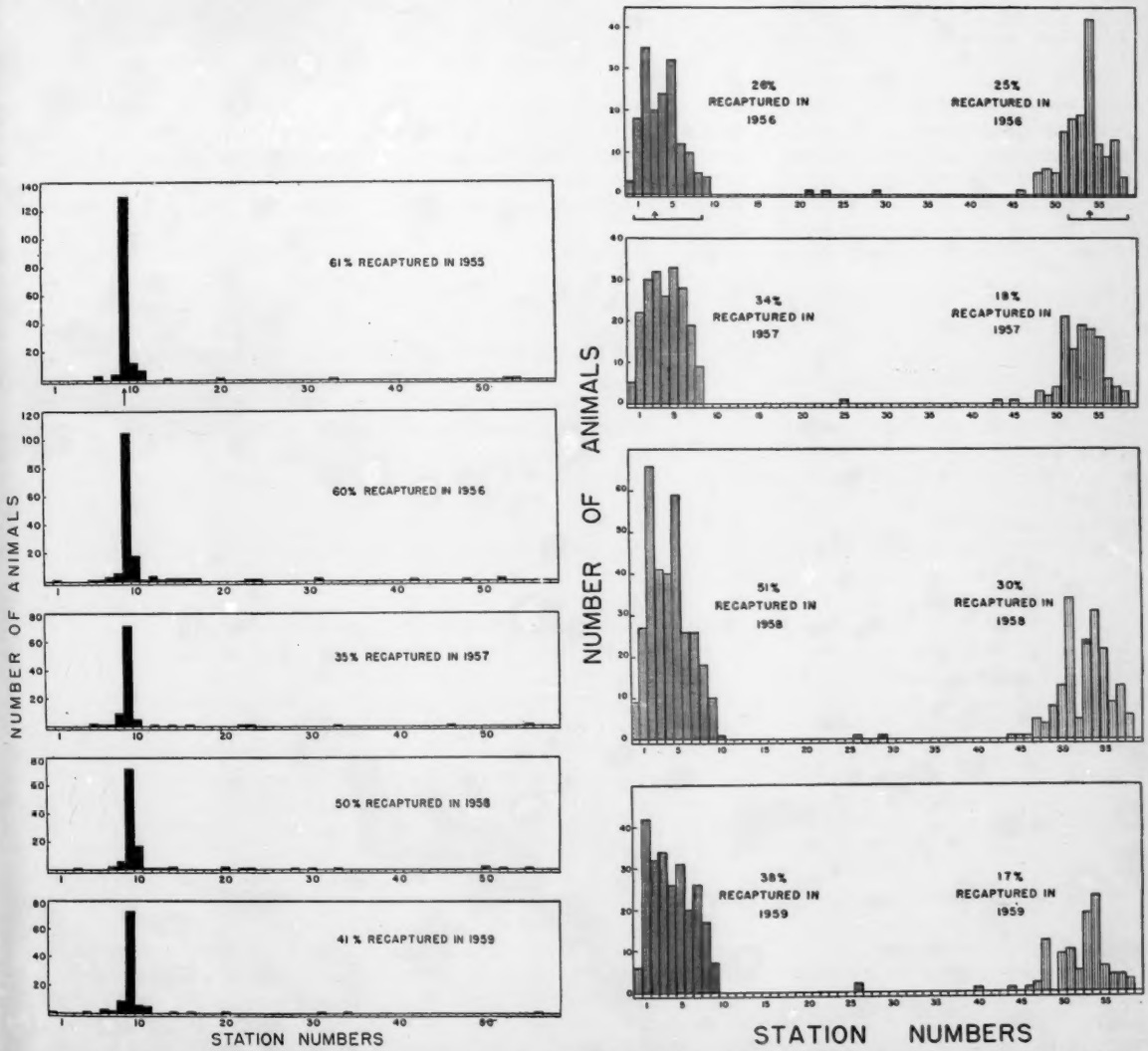
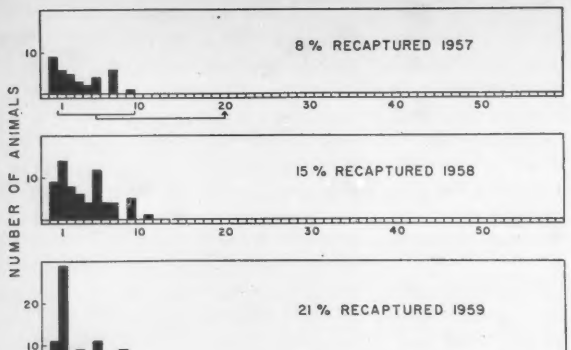


Fig. 2 (left). In 1953 adult newts were collected from a pool at station 9, marked to permit their subsequent recognition, and released in the same pool. The graphs show the locations where they were recaptured in later years, beginning in 1955. For recording the recaptures the stream was marked off into 50-yard segments or "stations." Fig. 3 (right). Graphs showing the locations of recaptures over a four-year period for two series of marked newts. The brackets and arrows indicate where each series was collected and released, respectively, in 1955.



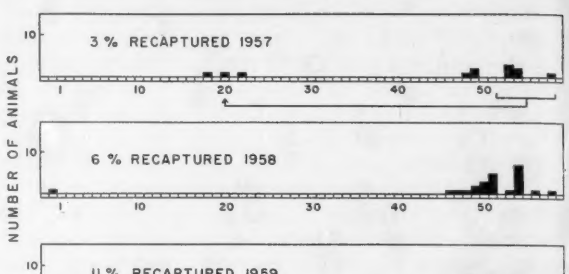


Fig. 4 (left). Graphs showing the return to the home segment of the stream of newts that had been displaced in 1956 to a point about half a mile downstream. Fig. 5 (right). Graphs showing the return, with a few scattered exceptions, of newts to the home segment of stream after displacement in 1956 to a point about one mile upstream.

and also for the low rate of mortality in the adult population.

To appreciate these results one must bear in mind that these are animals that in many cases have moved relatively great distances up and down the mountainside between successive breeding seasons.

Figure 3 shows the results, over a period of four years, of two additional series of marking experiments. These animals were collected from longer segments of stream, one series from the upper part of the experimental stretch and the other from the lower end of it. In each case they were all released in a single pool, near the middle of the segment in which they had been collected. The graphs showing their recapture in subsequent years are self-explanatory, and it is as evident as it was in the preceding series that the animals find their way back to the home segment of stream year after year with almost monotonous regularity and fidelity. In our daily patrol of the entire experimental stretch throughout the breeding season the location where these animals will be recaptured is so predictable that we are almost grateful when we encounter an exception—as we very seldom do.

The next experiments show that this behavior is based on a very positive affinity or sense of identification that the animals develop for their home segment of stream, and an ability to relocate it and recognize it after they have been displaced to foreign segments.

In the series represented in Fig. 4, adults were collected from the upper segment of the experimental stream, marked, and released downstream at station 20, about half a mile away. The graphs show the recaptures during the three succeeding years. Without exception, all of the animals recaptured had successfully relocated the home segment of stream.

It is true that the percentage of recaptures is lower than before, only 8 percent the first year. But you will note that the percentage has increased each year subsequently. This must mean that some of these animals had retained a memory of the home area, and the ability to recognize it, for at least three years. During that period, while still searching for their home base, they were unwilling to settle for any other segment of the stream. In a sense, then, the very ability to reproduce is dependent upon association with the home area. Why they should be so fussy and selective is difficult to see. One part of the stream is inherently as suitable for reproduction as another, as shown by the fact that the population breeds throughout the entire stretch.

Figure 5 shows the results with a similar series in which the animals were displaced for approximately a mile, from the lower end of the experimental stretch to station 20. The results are the same as before, except that the percentage of successful returns is lower, and there are a few animals that have apparently tossed in the sponge and settled for other than the home segment of stream. It is as if they have finally decided that the home stretch is simply out of reach and have resigned themselves eventually to acceptance of the breeding ground that is nearest at hand.

Incidentally, I should stress that these homing returns are made, not by way of the stream channel itself, but overland between breeding seasons; this, in view of the rugged nature of the terrain, makes the journey even longer and tougher.

One wonders how much further these animals could be displaced and still find their way home. Have we, in this last series, almost approached the "point of no return"? Until this year I would have been inclined to say so, but it appears that this is not the case.

In 1956 about a thousand females collected during the season from the experimental stretch were marked and released in a stream in a deep canyon on the other side of the mountain ridge that rises to the south of Pepperwood Creek (Fig. 1). The release point is perhaps three miles from the experimental stretch and is so inaccessible that we have not revisited it since the animals were transferred there. The ridge separating the two streams rises a good thousand feet above them, and frankly, I never expected to hear from these displaced animals again. However, near the end of this past spawning season they began to show up, and we recorded 18 individuals that were clearly members of the series. Next year I am sure we shall find more. There is not time to discuss the implication of this, or of other related experiments we have made, except to point out that whether it reflects a true homing search or not, as I am confident it does, it is a remarkable achievement by animals as relatively sluggish and slow-paced as newts. Considering the size of newts and their rate of locomotion, the distances involved are really very great.

Navigation or Random Search?

The next question is whether the animals we have displaced from one part of the experimental stretch to another find their way back home by random search or by oriented migration involving some form of true navigation.

Thus far, we have tested this in the following manner.

Figure 6 shows a star-shaped enclosure that we constructed of wire mesh near the streamside, about midway along the experimental stretch. The black line and arrow parallel the axis of the nearby stream and indicate the direction of flow of the stream. At the tip of each arm of the enclosure there is an opening into an escape-proof trap. In the center is a release box from which animals can escape by a spiral ramp through an opening in the lid of the box. Animals are placed in this box, usually in late afternoon, and the traps are checked for captured animals the following morning. Animals are collected from the water, either upstream or downstream from the enclosure, and placed in the release box, and the traps are examined the next morning to see whether the newts have started back in the right or in the wrong direction.

To summarize the results as briefly as possible, we found that if the animals are taken from distances not exceeding about 700 yards, then a very great majority, consistently 80 to 95 percent, orient their movements in the right direction. When they are taken from greater distances, their initial movements appear to be in random directions. We have tested this repeatedly and with large numbers of animals.

To evaluate the homing series described above in terms of these results with the "star-trap," the implication is that animals displaced more than about half a mile from their home area are stimulated by the displacement to initiate a searching behavior that is at first lacking in orientation. However, once they are carried by these random movements within striking distance of the home territory, they pick up signals or landmarks that enable them to navigate the remainder of the distance with remarkable directness.

Nature of the Signals

The next question, of course, is: What is the nature of the signals or landmarks, and what are the senses employed in their recognition?

One thinks first of all, perhaps, of the visual recognition of familiar landmarks or topographical features, since vision is so important in the homing behavior of certain other animals.

For reasons I shall not go into it is not simple to test this critically by the star-trap method, but we have tested it in another, perhaps even more direct and convincing, way.

We again collected a series of animals from the extreme upper end of the experimental stretch and displaced them to station 20. In this case, however, before they were displaced they were completely and permanently blinded by the

Fig. 6. A star-shaped enclosure, with an escape-proof trap at the tip of each arm, designed to test the ability of newts to orient their movements after transfer to the enclosure from other locations. The enclosure is situated near the breeding stream (the black line is parallel to the stream, and the arrow indicates the direction of stream flow), and animals to be tested are collected from upstream or downstream locations and placed in the release box in the center of the enclosure.

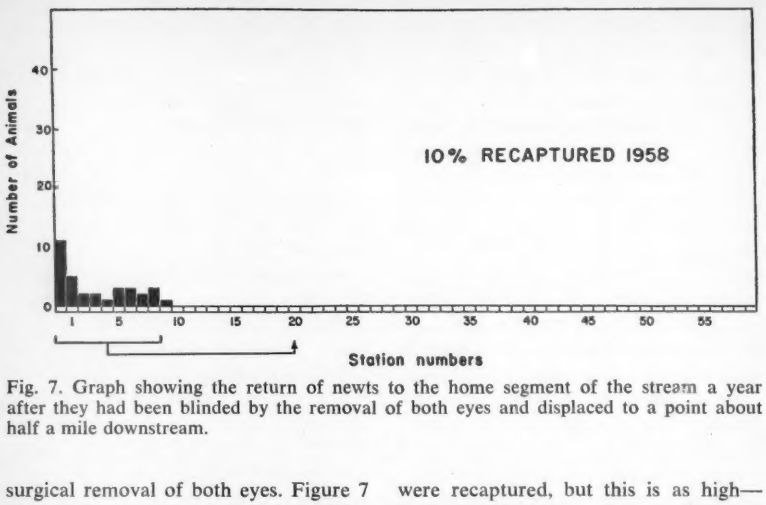


Fig. 7. Graph showing the return of newts to the home segment of the stream a year after they had been blinded by the removal of both eyes and displaced to a point about half a mile downstream.

surgical removal of both eyes. Figure 7 shows the recaptures a year later. Without exception all were back in the segment of the stream from which they had been taken. We were not too confident that these blinded animals would even survive, and when we found that their homing behavior was unimpaired we were admittedly surprised and impressed. Only 10 percent of the animals were recaptured, but this is as high—in fact a bit higher—than the first-year recaptures with the comparable series of normal or sighted animals described above. At the very least, this series shows that recognition of the home territory, once the animals relocate it, is certainly not accomplished through any visual associations that they have developed.

Another possibility that we have considered is that the animals orient their movements and identify the home segment of stream, or its bordering terrain, through kinesthetic memory—if there is such an expression. Any one of *us*, very conceivably, if we tramped repeatedly over an area of irregular terrain, might come to memorize its topographical features or pattern so completely that we could subsequently recognize any given spot within the area and orient our route accordingly in any chosen direction—even if we were blinded. Likewise the newts: During the rainy months preceding the breeding season they forage actively on the forest floor, and over the years they very possibly encompass and come to memorize the topographical pattern of a fairly large area of terrain extending upstream and downstream from the more restricted point where they eventually enter the water to breed.

We have tested this possibility, or have tried to test it, in the way described below, and the results indicate that, just as vision is not the means by which migration is oriented, neither is kinesthetic sense.

First of all, we simply covered the

Fig. 8. A platform that may be adjusted to different heights and degrees of inclination, designed to test the ability of newts to orient their movements when crawling on an unfamiliar and artificial terrain.

floor of the star-trap with a carpeting that would erase or conceal any of the natural irregularities of the terrain within the test enclosure. For this we used a plastic sheeting, known commercially as "Visqueen." However, animals tested under these conditions oriented their movements just as well, or seemingly as well, as when the floor of the enclosure was left in its natural state.

A somewhat fancier test and one that permits more refined analysis was performed by construction of a large platform (30 by 6 feet) that could be adjusted at different heights above the ground and could be tilted at different angles. A release box was placed at its center and a trap at each end (Fig. 8). The platform was installed near the creek, with its long axis parallel to the stream. Near the end of the past breeding season it was placed in operation in a sharply tilted position, with the downstream end elevated about five feet above the opposite or upstream end. Mixed groups of animals, half of them collected from downstream locations and half from upstream, were placed in the release box. In spite of the tilt, which presents an entirely new and foreign "topography" to the animals, the two groups sorted themselves out with very few errors, each moving in the direction of the home segment of stream. It seems clear from these tests that the animals do not "feel their way home" through recognition of familiar features of the immediate terrain in areas to which they have been displaced.

What are the possibilities that remain? I think that hearing can be discounted, and this leaves principally olfaction or related chemical senses. Do these animals smell their way home, and when they get there, does home—to them—mean a familiar and distinctive set of odors peculiar to the soil and vegetation along the streamside at that particular point? In animals as earth-bound as salamanders, living throughout their terrestrial phase in such intimate association with humid soil and all its products, I suppose it is not unlikely that the chemistry of their environment looms larger in their experience than do impressions of sight and sound. We do know that these newts have a remarkable sense of smell, or of chemical detection. It is by means of scent that the males detect the presence and location of females when the females enter the stream for breeding. A female, or even a sponge soaked in water in which females have been stored, dipped briefly in the water will excite and attract males situated many yards down-current.

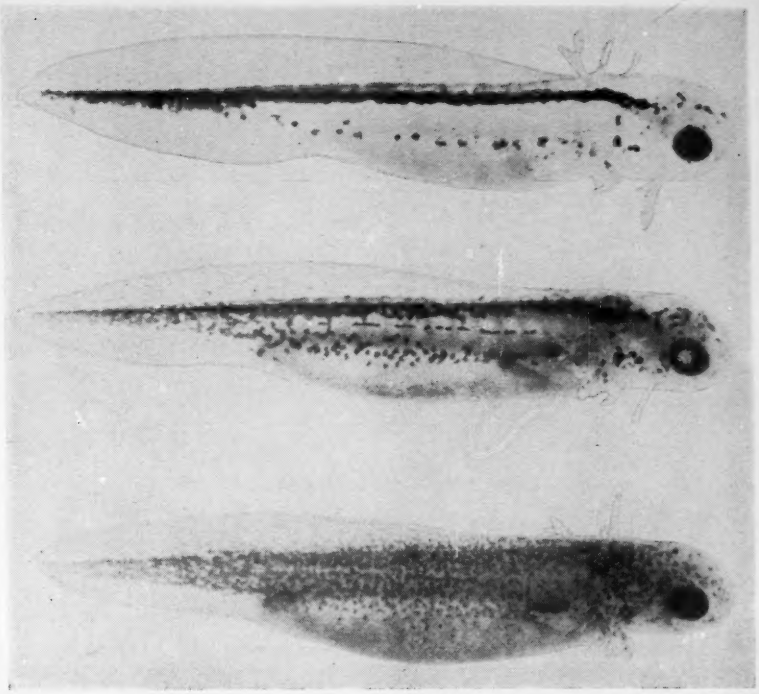


Fig. 9. Hybridization of *Taricha torosa* and *T. rivularis*. Young larva of (top) *torosa*; (bottom) *rivularis;* (middle) *rivularis* ♀ × *torosa* ♂ hybrid.

When we plug the nasal passages with Vaseline, as can be very effectively done by injecting barely melted Vaseline into the nares, and test the animals in the star-trap, orientation does seem to disappear or at least be greatly reduced. In fact, most of the animals fail to migrate at all and remain in the release box. However, the effects of a badly stuffed-up nose may prove to be merely traumatic or disturbing in nature and not due to the loss of the sense of smell as such.

So next year we plan to concentrate on a rather elaborate study of the possible role of odor, and I hope we shall be able to settle the matter. As I have told the chaplain at Stanford, if it proves not to be a question of odor, then the whole problem really lies more in his realm than in mine, and I will gladly assign it to one of his theology majors.

The Home Area

But whatever the sensory mechanism (or mechanisms) proves to be, I think the most interesting thing about the whole business is the simple biological fact that identification with the home area seems to mean so much to the salamanders. To them there is clearly "no place like home."

There are, of course, certain well-recognized advantages or consequences of spatial localization within animal populations. It tends to stabilize and equalize distribution of the members of a population, and accordingly to reduce competition. It assures the selection of suitable—that is, already tested—spawning sites and hence minimizes gametic wastage such as would occur if eggs were laid in portions of streams that go underground during the summer before the tadpoles could metamorphose. Since it reduces the effective size of breeding populations, it also minimizes the swamping of mutant genes that may arise, and thereby facilitates genetic differentiation or speciation.

It must also carry its penalties, however, since, as we have seen, animals are reluctant to enter an unfamiliar segment of stream—even though it may be completely suitable for breeding. This means, in effect, that accidental displacement can be tantamount to reproductive death, if the animals are unable to relocate—or are in any way prevented from relocating—the home area.

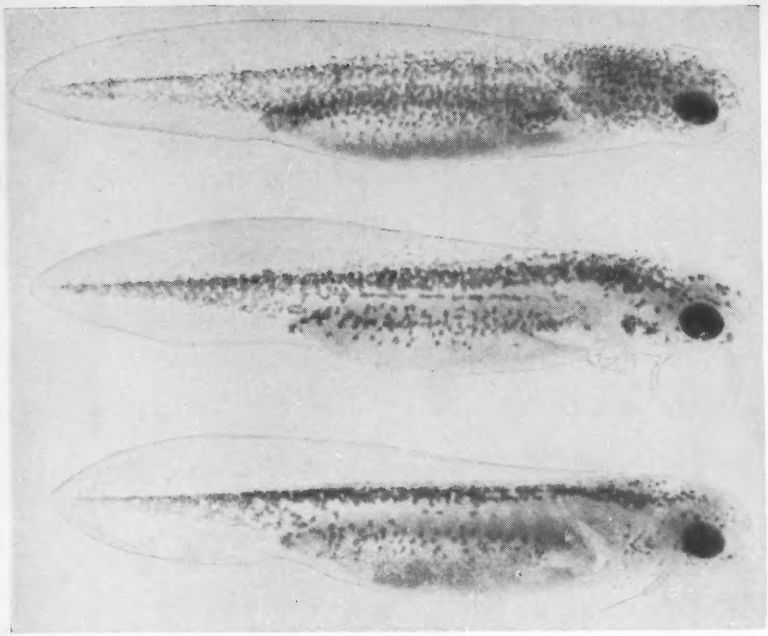


Fig. 10. Members of a backcross series (eggs of *rivularis* fertilized by sperm of a male *rivularis* ♀ × *torosa* ♂ hybrid) selected to show the F_2 segregation of pigmentary characteristics. (Top) *Rivularis*-type pigment pattern; (bottom) hybrid-type pattern; (middle) pattern intermediate to the other two.

But in any case, good or bad, it is a refinement of behavior that somehow I never expected to find so highly developed in animals that, until now, I must confess, I had always considered to be among the least discerning of vertebrates. In any event, I shall never again think of salamanders as mere egg-laying machines, created for the special benefit of the experimental embryologist.

Genetic Testing Ground

And now to turn briefly to another phase of the program. As I indicated above, in its inception the project at the ranch was designed to throw some light on the genetics and speciation of California newts, not on their ethology.

When one becomes involved in the systematics of a genus there are certain important questions that inevitably arise. Do or can the species form viable and fertile hybrids? If so, why do sympatric pairs of species preserve their separate identities—that is, what are the isolating mechanisms that prevent interbreeding? In the case of species that are *not* sympatric, would they, if it were not for their geographical isolation, prove capable of interbreeding successfully—and if so, what would the ultimate consequences be?

To test these and related questions we have attempted to convert the experimental stream at the ranch into a sort of genetic testing ground, or genetic melting pot. Since 1953 we have produced by artificial hybridization, and introduced into the experimental stretch as young tadpoles, some 200,000 hybrids of three different interspecific combinations. In addition, we have introduced tadpoles of the species that are not native to that part of the state. In other words, as I am sure some systematists will feel, we are really messing up nature rather badly in poor little Pepperwood Creek.

As I said earlier, it is too soon to know what the ultimate genetic consequences may be, if any. In order to have completed the program myself, I should have initiated it many years earlier. But we are beginning to learn a few things, and I shall run through some of them very briefly.

We have recaptured only a few mature hybrids as yet, but enough to know that they *can* survive and return to the breeding stream as adults.

Moreover, we have shown that the hybrids of the California species of newts are fertile—in both sexes. With the hybrids recaptured in nature, and others reared to maturity simultaneously in the laboratory, we have tested fertility by backcrossing the hybrids to the parental species by artificial fertilization. We have tested several interspecific combinations, and all have proved fertile, although we shall need to accumulate more data before it can be determined whether there is possibly some reduction in fertility.

This shows that hybrid inviability or infertility are not the reproductive barriers that isolate pairs of newt species that occur together in California. In the case of such species, that breed in the same bodies of water at the same season of the year, we believe that the barriers to interbreeding have instead a behavioral or psychological basis, and through a detailed study of courtship patterns (see cover picture) in the different species we are attempting to determine the nature of these ethological blocks to successful interspecific mating.

Thus far we have been unable to induce either sympatric or allopatric pairs of species to interbreed voluntarily, either in the laboratory or when confined together in escape-proof enclosures constructed in the stream itself. There is some indication, however, that these behavioral barriers to interbreeding disappear with hybridization. In the one case tested, when an adult hybrid male was placed in a mating enclosure with a female of the maternal species, successful mating and ovulation ensued. This suggests the possibility that if we can establish sizable populations of hybrids in the experimental area, introgression and consequent modification of the native population may occur.

The species of California newts have striking differences in larval pigment pattern, as I mentioned above, and when the hybrids of these species are backcrossed to the parental species, the offspring show a clear genetic segregation in their pigmentary characteristics.

Figure 9 (top) shows a young larva of *torosa* with its sharp pigment band, and (bottom) a larva of *rivularis* with its uniformly dispersed pigmentation. Between the two is a hybrid of the two species, and as one can see, it is roughly intermediate in its pigment pattern.

If we backcross an adult of the hybrid to one of the parent species the offspring show a spectrum of pigment patterns ranging between those characteristic of the hybrid and those characteristic of the backcross parent. Figure 10 shows three such backcross offspring, one with

a hybrid-type pattern, one with a *rivularis*-type pattern, and a third with an intermediate pattern. Other characters, such as the presence and size of the balancer and the size of the dorsal fin, also segregate in the backcrosses, and they segregate independently of one another and of pigment pattern. The ratios of segregation indicate that the numbers of genes that differentiate the species with respect to these characters are not very large.

There is not space to deal with the corresponding results of backcrosses involving other species combinations.

These are elementary genetic experiments, but since they involve my California newts, and since I have been for years uncertain of the feasibility of making any type of genetic analysis at all with these animals, the results are of special interest to me personally.

Conclusion

In presenting this account I am well aware that developmental biologists will possibly react with the feeling, "there goes another embryologist down the drain," and animal behaviorists will point with gratification, on the other hand, to the evidence that here is an embryologist who has finally seen the true light—even though he sees it dimly and is still an amateur. In any case, the reader in whose mind problems of speciation are uppermost, especially during this much celebrated Darwin Centennial year, can consider himself fortunate that he is not using experimental animals that yield genetic information as slowly as do California newts.

Notes

1. I wish to thank Mr. and Mrs. T. L. Hedgpeth and more recent owners of the ranch, particularly Mr. and Mrs. Stanley Richardson, Jr., for the facilities and courtesies they have generously extended to me. The project has been supported in part by grants from the National Science Foundation.
2. The genus was formerly designated *Triturus*.

Analysis of References in Critical Tables

National origin of physicochemical data is determined from literature citations in two research projects.

Bruno J. Zwolinski and Frederick D. Rossini

In recent years, particularly in the past decade, the advances and activities in the political, economic, and scientific areas of human endeavor have been examined from several points of view, in an attempt to delineate progress, major trends and their causes and interactions, and interrelationships with respect to future prospects and predictions in these areas, on both a national and an international level. In every analysis we are confronted with perennial questions as to the authenticity of the information or facts analyzed and their interpretation. Recently a thought-provoking article by Crane and Heumann was published entitled "*Chemical Abstracts* measures a nation's research" (*1*). Their thesis is that, since *Chemical Abstracts* has been working for over 50 years to cover the world's chemical literature as completely as possible, and since chemistry is a fundamental science closely integrated with a number of areas in the general field of physical, engineering, and biological sciences, the number of articles published in a particular country and abstracted in *Chemical Abstracts* should be a relative measure of national scientific activity.

As was to have been expected, the timely article by Crane and Heumann and the statistics which they gave elicited responses from readers which were both laudatory and critical in nature, particularly with respect to the total scientific activity—past, present, and future—of the United States and the U.S.S.R. In his brief comments on the letters received regarding the implications of the scientific information given in his article, Crane (*2*) pointed out specifically that the *Chemical Abstracts* statistics do not measure quality. He also doubted the availability of an effective measure of quality that would have general applicability.

A few months prior to the appearance of the article by Crane and Heumann, an independent study was undertaken in the Chemical and Petroleum Research Laboratory of the Carnegie Institute of Technology on the problem of national scientific activity and contributions. In this study the references by country of origin in the "General list of references" in the critical tables of the American Petroleum Institute Research Project 44 on "Data on Hydrocarbons and Related Compounds" and in the critical tables of the Manufacturing Chemists Association Research Project on "Properties of Chemical Compounds" were subjected to analysis.

Continuing Critical Tables

A few brief comments on the history of these two projects and on the nature of the selected values of physicochemical data with which they are concerned may be in order. Both of these projects on the compilation of continuing critical tables of basic scientific data are research projects of the chemical and petroleum research laboratory of the department of chemistry at the Carnegie Institute of Technology. The American Petroleum Institute Research Project 44 began work in September 1942, at the National Bureau of Standards, under the direction of Frederick D. Rossini. In June 1950 this project was moved to the Carnegie Institute of Technology. The purpose of the project is to compile and keep up to date a complete and self-consistent set of tables of critically se-

The authors are affiliated with the Chemical and Petroleum Research Laboratory of the Carnegie Institute of Technology, Pittsburgh, Pa.

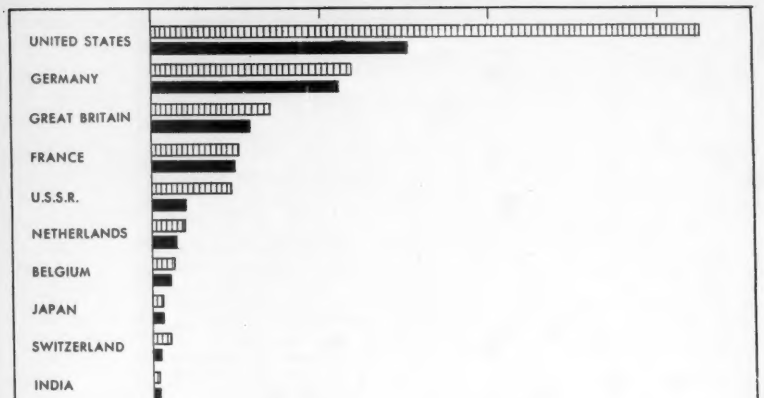


Fig. 1. Sources, by country, in the "General list of references" of the critical tables of the American Petroleum Institute Research Project 44 and the Manufacturing Chemists Association Research Project.

Table 1. Sources by country in the general list of references of the critical tables of the American Petroleum Institute Research Project 44 and the Manufacturing Chemists Association Research Project, at the Carnegie Institute of Technology, as of 30 June 1958.

Country of origin of the journals	API Research Project 44		MCA Research Project	
	No.	%	No.	%
Australia	5	0.07	0	0
Austria	50	0.73	9	0.21
Argentina	0	0	2	0.04
Armenia	0	0	1	0.02
Belgium	125	1.82	98	2.23
Brazil	0	0	3	0.07
Canada	57	0.83	27	0.62
China	0	0	6	0.14
Czechoslovakia	49	0.71	6	0.14
Denmark	14	0.20	8	0.18
Finland	6	0.09	4	0.09
France	521	7.57	493	11.22
Germany	1180	17.14	1104	25.13
Great Britain	698	10.14	570	12.97
Hungary	0	0	1	0.02
India	30	0.43	36	0.82
Italy	60	0.87	32	0.73
Japan	53	0.77	52	1.18
Mexico	0	0	1	0.02
Netherlands	186	2.70	131	2.98
Norway	0	0	4	0.09
Poland	12	0.17	7	0.16
Rumania	2	0.03	2	0.04
Spain	8	0.12	20	0.45
Sweden	14	0.20	28	0.64
Switzerland	97	1.41	43	0.98
U.S.S.R.	471	6.84	192	4.37
United States	3246	47.15	1514	34.46
Yugoslavia	1	0.01	0	0
Total	6885	100.00	4394	100.00

lected numerical data on the physical and thermodynamic properties of hydrocarbons and related compounds, such as certain oxygen, nitrogen, and sulfur derivatives of hydrocarbons. The companion or sister project, the Manufacturing Chemists Association Research Project, began work in May 1955, at the Carnegie Institute of Technology, also under the direction of Frederick D. Rossini. The aims of this project are similar in nature and scope to those of the API research project, except that the critical tables of the MCA research project on the physicochemical properties of chemical compounds will cover in time all known inorganic and organic substances with the exception of the hydrocarbons and certain related compounds.

The term *continuing critical tables* means tables of critically selected "best" values of properties and physicochemical constants, kept essentially up to date by revision at appropriate intervals. The selection of a "best" value involves various activities, such as appraisal and scrutiny of the data, of the method and procedure of measurement, and of the purity of the substance measured; weighting and mathematical analysis of the original data of each investigator; and theoretical, semi-empirical, and empirical correlation with molecular structure and with the variables of temperature, pressure, and so on. In many cases, new values are created, including values for many compounds never prepared by man. Such basic data on physical and thermodynamic properties are found scattered throughout the entire world literature of scientific journals in the general areas of physics, chemistry, and engineering. The staff has the responsibility to find such data wherever they may be published and no matter how obscure the journal. Only in rare cases are the data not obtained directly from published articles.

Analysis

It was the consideration of the quality of contribution that prompted us to analyze the "General list of references" in the critical tables of both the API and the MCA research projects. Our purpose was to ascertain the relative contribution of each country, as measured by the number of original journal publications used in the compilation and cited alphabetically by author's name

in the "General list of references" of the two projects. Since at the present time over 11,000 journal references are given in these two publications, it was felt that such an analysis would be meaningful. If we accept the authenticity and reliability of the data compiled in these tables of critical data, the analysis given below should give some measure of the quality of certain national scientific activities. Furthermore, since precise and accurate scientific data are the foundation for basic research and theoretical advances in all fields, this analysis may serve to indicate the national trends in fundamental research, as contrasted with applied research and development.

For this analysis, an actual count of the individual references was made. The recent "List of Periodicals Abstracted by *Chemical Abstracts*," together with the *Chemische Zentralblatt*, served as a guide for determining the origin by country of each specific scientific journal, where this was not obvious. Only in a very small number of cases, involving journals for which there had been a change of title or of place of publication or both, was it not possible to establish firmly the country of origin for a reference. If errors were made in these instances, these would have had no significant effect on the figures for the relative contributions of the largest contributors, which is the most meaningful information presented.

The following ground rules were adhered to in the preparation of the analysis: (i) All primary sources, such as journals, are enumerated; (ii) patents by each country of origin are tabulated as primary sources; (iii) a few secondary publications, such as treatises, compilations of data, and textbooks, are included (these represent only 2 percent or less of the total number of references); (iv) in the tabulation, "Great Britain" includes England, Wales, and Scotland; (v) "U.S.S.R." implies only Russia proper, all Soviet satellites, with the exception of East Germany, being regarded as separate countries; East and West Germany are counted as one country (*3*).

Results

The results of the analysis are summarized in Table 1 in terms of the absolute number and the percentage contribution by country for each of the two sets of critical tables. In Table 2 are listed, with their percentage contributions, the countries whose journals provided the largest number of references for the critical tables of the two projects, together with a comparison of the information from *Chemical Abstracts* by Crane and Heumann (*1*). It is seen that the figures from the "General list of references" of the API Research Project 44 and of the MCA Research Project are in substantial accord qualitatively, and that these figures agree reasonably well with those of Crane and Heumann for the period 1909 to 1956.

Figure 1 shows graphically the information reported in Tables 1 and 2.

Table 3 gives some facts and figures regarding the critical tables of the American Petroleum Institute Research Project 44 and the Manufacturing Chemists Association Research Project.

Table 2. The countries whose journals provided the largest number of references for the critical tables of the American Petroleum Institute Research Project 44 and of the Manufacturing Chemists Association Research Project and for *Chemical Abstracts* (*1*).

Country* of origin of the journal	API Research Project 44 (%)	MCA Research Project (%)	*Chemical Abstracts* 1909–1956† (%)	*Chemical Abstracts* 1956 (%)
United States	47.15	34.46	32.2	28.4
Germany	17.14	25.13	20.2	8.4
Great Britain	10.14	12.97	11.9‡	9.2‡
France	7.57	11.22	8.4	6.0
U.S.S.R.	6.84	4.37	6.5	13.5
Netherlands	2.70	2.98	2.0	1.3
Belgium	1.82	2.23	0	0
Japan	0.77	1.18	3.7	10.4
Switzerland	1.41	0.98	1.4	1.9
India	0.43	0.82	2.0	2.4
Italy	0.87	0.73	3.2	4.1
Sweden	0.20	0.64	0	0
Canada	0.83	0.62	0	0
All others	2.23	1.67	8.5	14.4
Total	100.00	100.00	100.0	100.0

* Arranged in order of the number of references in the critical tables of the Manufacturing Chemists Association Research Project. † Mean of the figures given by Crane and Heumann (*1*). ‡ Obtained from the figures reported for the British Commonwealth and the factor 0.84 quoted by Crane and Heumann (*1*).

Discussion

One must keep in mind that the figures presented in Tables 1 and 2, and in Fig. 1, represent a special kind of compound averages—averages for different classes of compounds, with different kinds of properties, in different

Table 3. Facts and figures regarding the critical tables of the American Petroleum Institute Research Project 44 and the Manufacturing Chemists Association Research Project, at the Carnegie Institute of Technology, as of 30 June 1958.

Item	API Research Project 44	MCA Research Project
No. of chemical compounds listed	2,138	1,451
No. of individual numerical entries	227,293	12,214
No. of references	6,885	4,394
No. of valid sheets in a complete set of tables	1,807	393
Oldest reference cited (date)	1822	1826
Longevity of the project (yr)	15.5	3
No. of recipients of the data sheets:		
in the United States	842	1,028
abroad	332	153
Total	1,174	1,181
Total No. of countries receiving data sheets	34	30
No. of countries* represented in the "General list of references"	22	27

* For comparison with these figures, consider the following: No. of countries in the world having one or more institutions of higher learning (*4*), 80; No. of countries who are members of the United Nations, 81; total No. of countries in the world (*5*), 115.

scientific areas, taken over different periods of time and influenced by different economic and political factors and by advances in scientific theory and practice, with their associated fads and prejudices. In view of this fact, one is tempted to say that any kind of agreement or disagreement is rather fortuitous and perhaps meaningless.

As to whether this analysis of the references in the two sets of continuing critical tables constitutes a sound basis for delineating the quality of basic physicochemical research on an international level, only time will tell. One fairly obvious and not unexpected result of this study is the finding that the principal countries of the world—those in which there is the greatest scientific activity—are the largest contributors of such basic scientific physicochemical data.

Analysis of the references in the continuing critical tables of the American Petroleum Institute Research Project 44 and the Manufacturing Chemists Association Research Project will be made at regular intervals, and appropriate reports will be issued. In particular, it is planned to evaluate the change in percentage of contributions with time for the several countries. This will be important in giving us a projection into the future. It is expected that such an analysis will show a high upward rate of change for the U.S.S.R., as was shown by the figures derived from *Chemical Abstracts*.

References and Notes

1. E. J. Crane and K. F. Heumann, *Chem. Eng. News* **36**, 65 (1958).
2. E. J. Crane, *ibid.* **36**, 13 (1958).
3. Grateful acknowledgement is made to Harry J. Ries and James T. Kerr for assistance in the preparation of this information.
4. M. M. Chambers, *Universities of the World Outside the U.S.A.* (American Council on Education, Washington, D.C., 1950).
5. W. S. Woytinsky, *World Population and Production* (Twentieth Century Fund, New York, 1953).

Eugene F. DuBois, Environmental Physiologist

Eugene F. DuBois died 12 February 1959, after distinguished service to science and to his country. He was born in West New Brighton, Staten Island, 4 June 1882. His father died when Eugene was nine. His mother, who attended opera in New York regularly from the age of 8 to 80, spoke French and German fluently and studied Spanish after she was 70. Eugene felt that he got the best part of his education at home during his first 12 years, thanks to his mother, a happy environment, a house full of books, and walks through the woods and fields. In 1897, at 15 he transferred from the Staten Island Academy to Milton Academy, where he learned from one of his teachers, James Hattraik Lee, that study could be good fun. He spent some summers in Europe, but in the summer of 1898 he and his brother Arthur, as volunteer orderlies, helped care for patients with typhoid fever and dysentery at the Army Hospital at Camp Wyckoff, Montauk Point. Eugene then decided to study medicine.

He rated his three years in the humanities at Harvard easy, despite the fact that he graduated *cum laude*. He arranged his courses so that he could row on the Charles River every afternoon. He later regretted having taken only the minimum requirement in chemistry and biology, commenting that he did not get a good education at Harvard but did get the desire and drive to educate himself, a stimulus that lasted throughout his life.

DuBois entered Columbia College of Physicians and Surgeons in 1902. At that time classes were large, standards were low, and instruction was didactic. Students supplemented their medical education by joining private quiz classes and by substituting as interns. Only in this way was it possible to pass the stiff examinations given by the hospitals to select interns. With Charles Lieb, DuBois was fortunate in being selected to serve as "clinical clerk" in the summer of 1905.

After graduation in 1906, DuBois spent six months with Hanke in Berlin studying pathology. He returned to residency at Presbyterian Hospital. This was in the era of transition, in New York, from the old traditions to the beginning of modern medicine. Leaders in the transition were Graham Lusk, Samuel Meltzer, Theodore Janeway, and Christian Herter. The Rockefeller Institute was making its influence felt, and the Harvey Society was founded. DuBois and several of his fellow interns mapped out careers in scientific medicine. After two years as intern and house officer, DuBois went, on the advice of John Howland, to Berlin to study metabolism for six months under Theodore Brugsch. As happens even today, the young scientist accumulated notebooks of data without adequate information on how to write a scientific paper. Graham Lusk came to his rescue during his stay in Berlin and in typical fashion was generous of his time in helping DuBois recalculate the data and write the paper. The two men became lifelong friends.

DuBois returned to Presbyterian Hospital in 1909, to begin work in pathology under Eugene Opie. There he was associated with Jonathan Meakins and Russell L. Cecil. He held various appointments at Cornell beginning in 1910. He was professor of medicine from 1930 until he became professor of physiology in 1941. In a sense he asked for the latter post. When Bronk, after a 1-year tenure, resigned as professor of physiology at Cornell to return to the Johnson Foundation, DuBois remarked that "it was a chair any professor of medicine would be glad to accept." Almost immediately he was offered the position and accepted it.

DuBois had hesitated about departing for his second period of European study in 1908 because he had just become engaged. However, his fiancee insisted that his career should come first. After he married Rebeckah Rutter in 1910, his small salary compelled him to open an office in their apartment and practice medicine a few hours a day. While never an athlete, DuBois enjoyed many forms of sport and throughout his life maintained a high degree of

physical fitness. While at Harvard he rowed on the Weld crews; in medical school he exercised in the gymnasium, and from 1924 until at least 1948 he ran about a mile in Central Park almost every morning before breakfast. He had virtually no illness until his stroke a few years before his death.

DuBois' military career began shortly before World War I was declared. It was then that his duties in the Bureau of Medicine and Surgery demonstrated his ability as an environmental physiologist. He became an expert in the toxic environments found in gas warfare, in submarines, and in deep-sea diving, and an expert in aviation medicine. In 1919 he received the Navy Cross. In World War II he was on duty as a captain for three months of each year, chiefly as an adviser in aviation medicine. From 1940 to 1945 he was chairman of the Committee of Aviation Medicine organized by the National Research Council and later brought under the Office of Scientific Research and Development. After the war he was awarded the President's Certificate of Merit. When DuBois last wrote me, in April 1958, he said he was still enrolled in the Naval Reserve and would volunteer his services again in case of a national emergency—this despite the fact that he was nearly 76 years old and was recovering from a stroke. The military services are indebted to him for inspiration, encouragement, and training given to many who hold or have held posts of importance. For example, DuBois was especially

Eugene F. DuBois

proud of James D. Hardy, who has been for several years director of research at the Navy's Aviation Medical Laboratory, Johnsville, Pa. Another of his protégés, Carl M. Herget, is chief of the Biophysics Division, U.S. Army Chemical Warfare Laboratories.

DuBois is best known for his metabolic studies, particularly those related to temperature regulation. His *Basal Metabolism in Health and Disease*, published in 1924 and again in 1927 and 1936, built for him an international reputation. In 1937 Stanford University invited him to give the Lane medical lectures. He chose for his topic, "The Mechanism of Heat Loss and Temperature Regulation"; his book under this title was published by the Stanford University Press in the same year. These five lectures contain the highlights of a quarter-century's research in the fields of clinical investigation and environmental physiology. Among his many associates during those years were several who became leaders in clinical investigation in Boston; these included Howard Means, Frances Peabody, Joe Aub, and Soma Weiss. His patron saint was Graham Lusk.

In recognition of his attainments in science, medicine, and administration, DuBois received many honors. He was elected to membership in the National Academy of Sciences, received an honorary D.Sc. from the University of Rochester in 1948, and was president of several societies.

DuBois is best known to most medical scientists for the metabolic standards he and his engineer cousin, Delafield DuBois, helped establish. Physiologists, including DuBois himself, have rated as of greater interest his studies of metabolism in fever and his research on methods of heat loss and temperature regulation. DuBois, Barr, and Hardy were the first to prove that the body could give off as much heat through a cool skin as through a warm skin. He was a leader in environmental physiology for the last 25 years of his life. I came to know him best after he retired in 1950, and I admired his determination and success in remaining alert and active as a scientist until his death.

D. B. DILL

Joppa, Maryland

Science in the News

Current Antarctic Research Program Designed To Fill Gaps in IGY Study

Among the scientific projects now commencing at U.S. bases in Antarctica are a number of biological and geological studies that mark the start of an attempt on the part of the National Science Foundation, which supports antarctic research, to fill some of the gaps in the scientific study of the continent which were left at the end of the International Geophysical Year, in December 1958. The studies—some new and others continuations of earlier studies that are being resumed with the current antarctic summer—are in such areas as glaciology, geology, biology, and oceanography. New traverses and aerial mapping operations are planned, as well as studies of animal and insect life and studies of psychological stress in those who work under antarctic conditions.

The element common to many of these studies is that the study can be carried out by one man or a group of men working independently in a relatively small area of investigation. The psychological study, for example, is being conducted by one man accompanying a traverse party. The worldwide network of stations established during the IGY is no longer in operation, and there is, therefore, no need to limit scientific work to fields such as meteorology, seismology, and ionospheric physics that provide data of particular value when simultaneous readings can be taken at many points of the earth. Much of the work, however, still requires constant readings and the keeping of records throughout the year.

Both the National Science Foundation and the Navy, which send approximately the same number of men to "winter over" at the four major U.S. stations, are currently implementing the new policy. The Navy provides logistic support for the scientific program. The foundation is encouraging investigators, from the station leaders down to the technicians who take the thousands of readings during the year, to go down to "the ice" as the continent is known locally, with well-defined plans for personal research projects. Some of these projects, especially those of the technicians, are necessarily modest because of the demands of their primary jobs. The Navy is making a similar effort, concentrating on the doctors who are in charge of the military personnel at most of the isolated bases. One study conducted with Navy help is "Operation Snuffles," which is concerned with ailments of the upper respiratory tract.

Two NSF-supported projects representative of the many that have been undertaken are those of Edward Zeller, of the University of Kansas, and John Dearborn, of Stanford University. Zeller is continuing a project designed to determine how long low-temperature conditions have existed in the Antarctic. With one assistant, he collects samples of various carbonate rocks from the exposed, snow-free, dry valley areas west of the Naval Air Station on McMurdo Sound. By comparing the thermoluminescence of these samples under antarctic and normal conditions, Zeller will be able to make a determination of the length of time the rocks have been subjected to low temperatures.

Dearborn, who is a field assistant to Donald E. Wohlschlag, associate professor in the department of biological sciences at Stanford, is studying under-ice plankton and detritus at the air station on McMurdo Sound. He is also investigating the comparative ecology of under-ice fauna. Dearborn and his associates at McMurdo have an advantage over most scientific workers in Antarctica because a large biological laboratory has been established at the naval base.

Programs of Other Nations

There are, in all, 12 countries now doing research in Antarctica. The programs of the other 11 are undergoing the same general shift in emphasis that can be seen in the U.S. program. Certain commitments left over from the IGY are being met, but the trend is toward local studies. The New Zealanders are conducting a number of small programs that are reported to be excellent in conception and execution. At their main base, Scott Station, which is about 3 miles from the U.S. base on McMurdo Sound, they are engaged in studies of upper-atmosphere physics, including work on auroras and "whistlers," and in geological and mapping activities. An American, Mark Gordon, will participate in the study of auroras at Scott Station during the next winter season.

The French program, according to observers, has been in abeyance since the closing of the Charcot Station in Wilkes Land. A Polish station is reported to be carrying out projects in glaciology, geology, and gravimetry. Australia has a well-rounded program, in which the emphasis is on glaciology, geology, mapping, and upper-atmosphere work. The Japanese program is limited, according to reports, to on-site studies and involves no traverses, no oceanographic investigations, and only minor work in glaciology. The Belgian station located in Queen Maud Land, is conducting work in glaciology, mapping, and geology and is planning a number of traverses. A Norwegian station, also located in Queen Maud Land, is reported to be reducing its effort, possibly with the intention of ending operations in the near future. Work at stations established by the United Kingdom is said to be limited to surveys and mapping on the Palmer Peninsula, and no traverses are planned. At its own stations and at Ellsworth Station, which it has leased from the United States, Argentina is conducting meteorological and glaciological studies. According to reports, many of the Argentine stations are primarily land-holding establishments, set up with an eye toward future territorial claims. With the signing of the treaty on Antarctica this month in Washington, Argentina may give up some of her 11 stations. The treaty, in effect, freezes all past territorial claims and prohibits the making of any new ones for the period it is in force.

The Soviet Union plans extensive work in Antarctica during the current summer. A traverse, which, if completed, will be one of the longest ever made, is now under way. Starting from

the coastal base of Mirny in Wilkes Land, the traverse party will go to the interior base of Vostok, will proceed from there to the U.S. station at the South Pole, and will continue to the Point of Inaccessibility and on into an unexplored mountainous area in Queen Maud Land. The traverse is expected to cover 3600 miles. In addition, Soviet scientists are engaged in studies in the fields of meteorology, geomagnetism, geology, and glaciology and are prospecting for minerals. Reports also indicate that the Soviets are placing great stress on mapping.

Chile is reported to have only a modest program under way on the continent of Antarctica. Its concern, according to reports, is much like Argentina's—to carry out a land-holding operation for political reasons. As in the case of Argentina, this effort may be suspended with the ratification of the treaty on Antarctica.

Tractor train led by a U.S. Navy weasel on the 647-mile trail from Byrd Station to Little America Station in Antarctica. D-8 tractors with raised plows pull supply sleds and 20-ton wanigans—mobile structures with messing and sleeping facilities. [Official U.S. Navy photo]

Selection of Programs

In its program in support of antarctic activities, the National Science Foundation makes no attempt to dictate the direction that scientific work on the continent shall take. Instead of calling for proposals in certain fields, the foundation limits itself to making a selection from the proposals it receives from individual scientists, governmental agencies, and private organizations such as the Arctic Institute of North America.

As proposals come in from scientists and organizations throughout the United States, NSF personnel evaluate them on the basis of the following criteria: Is there enough money to support a project in the particular field of science that the proposal deals with? Is the proposal scientifically promising? Can personnel be found to carry out the program? Is the proposal such that it can be carried out with the support facilities currently available in the Antarctic? In answering these questions, the administrators of the antarctic program, working under T. O. Jones, seek the services and advice of other scientific and governmental organizations. On the question of feasibility of a proposal, the Navy has an important voice. On the question of scientific promise, opinions are sought from personnel of the foundation, from the Committee on Polar Research of the National Academy of Sciences–National Research Council, and from the government's Interdepartmental Committee on Antarctic Research. When a proposal has been approved on all four counts, the field investigators and their equipment are sent by military plane or transport to New Zealand and then to the continent of Antarctica. Most of the individual research projects are carried out during the antarctic summer, which lasts from October to March. Temperatures during this period are high enough to allow extended outdoor work, and the sun never sets. The air base at McMurdo Sound provides helicopter and other air transportation to inland and coastal stations.

Administrative Concepts

Although help in administering this country's antarctic program may be given by other agencies, the main burden of the job rests with Jones' office in the National Science Foundation. With the end of the IGY, basic policy had to be formulated for the continua-

Glacier tip with melt streams and melt lake in a dry valley area in Antarctica. Such areas remain snow-free during most of the summer months—October through March. The continental ice cap may be seen in the far background. [Official U.S. Navy photo]

tion of a scientific program on the continent of Antarctica. Two basic administrative concepts are used by Jones and his staff (which is composed largely of former IGY personnel): that scientific personnel at the various stations should be free of housekeeping duties during their stay, and that a dual command structure should be established, with a Navy doctor in charge of the service personnel who maintain the bases and a scientist in charge of the scientific party. This set-up has worked well, and differences between the military and the parties of scientists have been rare. The general attitude is one of cooperation, and many of the Navy personnel take considerable interest in the work of the scientists.

The National Science Foundation administrators have developed a familiarity with naval practices and procedures that is of value to them in their conduct of the program. When it has been determined that a certain action is needed, Jones makes a request to Rear Admiral David M. Tyree, commander of the Antarctic Support Force, who in turn issues an order to the relevant unit under his command. A parallel procedure is followed by representatives of the scientific parties at the various stations on the continent.

Jones, who had been acting head of NSF's Office of Scientific Information Services before taking on his current job, expects that the antarctic program will continue indefinitely. Behind the program and the new direction that it is taking lies a great deal of his thinking. In a recent interview in Christchurch, New Zealand, he explained his position on the continuation of the program: "In order to sustain and keep a research program virile over a long time, I believe it is essential to shift away from the wholly-planned program, carried on in the field by hired technicians and analyzed by scientists at machines at home, to support of the individual in a research program in which he is deeply interested, while at the same time maintaining a reasonable balance of subject areas."

Chemistry Teaching Method Being Tested

A new method for teaching beginning chemistry, one that teaches students "to think like chemists," is now being tested in nine United States high schools, according to Laurence Strong, professor of chemistry at Earlham College and director of the project that developed the method. The present test, financed by a $90,000 National Science Foundation grant, is the culmination of approximately 3 years of work by a number of college and high-school chemistry teachers. The program, which has been made possible by financial contributions from various foundations, has had the support of the Division of Chemical Education of the American Chemical Society.

The initial conference leading to the new course was held at Reed College in the summer of 1957, under the direction of Arthur Scott and Harry Lewis. The meeting was financed by the Crown Zellerbach Foundation. A year later the group met again, at Wesleyan University, this time supported by the National Science Foundation. A writing conference was held last summer, at Reed College, devoted to the actual construction of the new course and the writing of the textbook. This work, also financed by NSF, was directed by Strong and by Arthur H. Livermore, professor of chemistry at Reed.

The Idea for the Method

The idea for the new teaching method grew out of the conviction of Strong and others that the conventional beginning-chemistry course dealt with isolated facts and technology which students were required to memorize, rather than with the logical pattern of chemistry. As Strong explains:

"Until now the emphasis in beginning chemistry has been on the factual material of chemistry, but not on what lies behind the facts. No basis for understanding the basic ideas of chemistry has been given. The new course will present the facts against a background of ideas. It is our hope that tests will show that students can take these ideas and work out the answers to new problems for themselves."

Called the "Chemical Bond Approach Project," the new method is based on the idea that atoms are tied together by bonds and that the manner in which they are tied together is an important factor in determining the chemical makeup of a substance. Strong says that if students understand this basic factor, "they can gain an initial insight into the possibilities of predicting the properties of yet-to-be-made compounds. By such a procedure the student . . . is able to focus on some of the most dramatic aspects of chemistry. There are great possibilities in this new approach of enlisting the interest of students at every level of ability."

High schools which are participating in the present test are Central High School, Phoenix, Ariz.; Leonia High School, Leonia, N.J.; Chester High School, Chester, Pa.; Los Angeles High School, Los Angeles, Calif.; Shortridge High School, Indianapolis, Ind.; Grant High School, Portland, Ore.; Lawrenceville School, Lawrenceville, N.J.; University of Illinois High School, Urbana, Ill.; and Sunset High School, Beaverton, Ore. The teachers who are using the experimental course were all participants in last summer's conference at Reed.

Collaborating with Strong in the direction of the project are Livermore; H. A. Neidig, professor of chemistry at Lebanon Valley College (Annville, Pa.); and M. Kent Wilson, professor of chemistry at Tufts University. Periodic tests are given students who are taking the new course in order to determine their progress. The course will probably be revised at the end of the experiment and then released in final form.

Bureau for Research on Sources of Poverty Urged; Committee Formed for Social Action

Some problems in American society and some new approaches to their solution were discussed last month in Washington at the closing session of the biennial round-table conference of the American Public Welfare Association. Agnes E. Meyer, widow of the former chairman of the board of the Washington *Post and Times Herald*, addressing the group, called for a federal research bureau to study the causes of poverty. Such a study, she said, offers the only way of "breaking the vicious circle whereby dependency, disease, and crime are handed down from generation to generation. . . ." Later in her speech she disclosed that a committee of natural and social scientists has been formed to "narrow the gap between knowledge and action" in meeting the nation's pressing social needs.

Mrs. Meyer suggested that a bureau to study the sources of poverty could properly be set up in the Department of Health, Education, and Welfare. State offices working with the department now have research staffs that

could readily be augmented and improved. The cost of expansion for such a study to "understand the nature of our social illnesses" would be only a few million dollars. The flow of the preponderance of all tax revenues to the federal government, according to Mrs. Meyer, has made it impossible to carry out the suggestion that state and local funds be used more extensively to support the public-assistance program. About 75 cents of every tax dollar now goes to the federal government, she reported, with the state and local governments getting only 15 and 10 cents, respectively. "Obviously," Mrs. Meyer said, "our state and city governments cannot meet their social obligations without federal aid or without a thorough revision of our tax structure."

New Committee Described

Mrs. Meyer ended her talk with a description of a new committee, of which she is a member, which was recently formed to integrate the results of research with programs attacking social problems. The group, called the Committee on Problems of the American Community, is composed of 16 natural and social scientists from universities and foundations throughout the country. It will not conduct new research but will experiment with ways of applying the results of past research.

The first problem that the committee will concern itself with is that of the social aspects of housing—the relationship of housing to the problems of family stability, population trends, child welfare, minority groups, care of the aged, juvenile delinquency, and community organization. The committee will operate for one year within the Conference Program on Public Affairs of the Brookings Institution in Washington.

Lawrence Memorial Award Established by AEC

The Atomic Energy Commission has announced the establishment of an Ernest Orlando Lawrence Memorial Award for recent, especially meritorious contributions to the development, use, or control of atomic energy in areas of the sciences related to atomic energy, including medicine and engineering. The award was established to honor the memory of the late Ernest O. Lawrence, director of the Radiation Laboratory at Berkeley and Livermore, which is operated for the commission by the University of California. Lawrence died in 1958. The laboratory has since been named the E. O. Lawrence Radiation Laboratory in his honor.

The award, which will be made by the commission upon the recommendation of its General Advisory Committee and with the approval of the President, will consist of a medal, a citation, and up to $25,000. It will be made to not more than five recipients in any one year, in the amount of not less than $5000 each; it will not necessarily be made every year. It will be presented in the spring of the year, to men or women who are not more than 45 years of age, at a time and place to be determined by the commission. The recipients must be United States citizens.

In contrast to the commission's Fermi Award, the Lawrence Award is designed especially for the recognition of young scientists who have made recent outstanding contributions to the development, use, or control of atomic energy. The Fermi Award is based upon the lifetime contributions of theoretical and experimental scientists.

Science Talent Search Shows Sharp Increase in Interest

Steadily increasing interest in scientific training and professional careers is reflected in the growing number of students competing in the annual Science Talent Search for the Westinghouse science scholarships and awards, according to Watson Davis, director of Science Service. More than 33,000 sets of entry materials have been requested by the teachers and counselors of outstanding high-school seniors who wish to compete in the 19th Science Talent Search. This represents an 18-percent increase over last year, according to Dorothy Schriver, executive secretary of Science Clubs of America, which conducts the Search as an activity of the Science Service science youth program.

A comprehensive science aptitude examination to measure ability in scientific thinking is being given for the Search this month in public, private, and parochial schools throughout the United States. The 2½-hour test may be scheduled for any time up to 27 December; all completed entry materials must arrive at Science Clubs of America headquarters in Washington by midnight of that date Requests for the examination will be filled up to the last day.

In addition to taking the aptitude test, each applicant must submit school records, faculty recommendations, and a report of approximately 1000 words on a scientific study he or she has carried out. Research papers entered last year dealt with such subjects as a linear induction accelerator for use in studying resonant nuclear reactions; six unusual land snails found in the Maryland Piedmont; new postulates in Boolian algebra; measurement of the infinitesimal amount of heat released when a solid is immersed in a liquid; the possible influence of radioactivity in speeding up evolution; the finite sums of polynomials; somersaulting Egyptian spiny mice; the biochemistry of vinegar; the digestive processes of the Venus-flytrap; and the use of solar energy for space cooling.

Approximately 10 percent of the students who fulfill all entry requirements of the Science Talent Search will be named members of the honors group and recommended to colleges and universities for admission and scholarship awards. From the honors group, 40 top winners will be selected to come to Washington for the Science Talent Institute, 3–7 March 1960. During the 5-day institute the 40 winners will be interviewed, and their potential ability will be further evaluated by a board of judges to determine how $34,250 in science scholarships and awards provided by the Westinghouse Educational Foundation shall be distributed.

Volunteers Needed To Record Scientific Textbooks for the Blind

Scientists can perform valuable service by reading aloud textbooks for Recording for the Blind, which has headquarters at 121 E. 58th St., New York, N.Y. The organization has 14 centers throughout the country. A volunteer must be able to devote at least 2 hours a week to recording. It takes 25 hours to read an average textbook of 500 pages. To be effective, a technical work must be recorded by someone with a knowledge of the subject.

More than 1400 blind persons now use RFB's recorded books, which they obtain free of charge from 12 regional public libraries. About 700 of these subscribers are college students; the rest are adults who wish to continue their education.

Recording for the Blind has recorded

at least 150 science textbooks to date. About 50 percent of these are in mathematics and biology. There are only 19 chemistry textbooks and 18 physics textbooks on the list.

New Journals

Biochemical and Biophysical Research Communications. vol. 1, No. 1, July 1959. Paul Berg *et al.*, Eds. Academic Press, 111 Fifth Ave., New York 3. Monthly. Individual subscribers, $6.50; others, $12.

Botanica Marina. Spring 1959. T. Levring, chairman, Ed. Committee. Cram, De Gruyter, Hamburg, Germany. Quarterly.

Bulletin of the United States Antarctic Projects Office. vol. 1, No. 1, Sept. 1959. U.S. Antarctic Projects Office, Washington 25, D.C.

Cern Courier. No. 1, Aug. 1959. European Organization for Nuclear Research, Geneva 23, Switzerland. Monthly. Free.

Current Anthropology (pre-issue). Sept. 1959. Sponsored by Wenner Gren Foundation for Anthropological Research. Sol. Tax, Ed. The Editor, University of Chicago, 1126 E. 59 St., Chicago 37, Ill. Bimonthly. $10.

Experimental Neurology. vol. 1, No. 1, Apr. 1959. William F. Windle, Ed. Academic Press, 111 Fifth Ave., New York 3, 6 issues, $16.

News Briefs

A Forensic Science Society was formed recently during a well-attended meeting at Nottingham University in England. The object of the society is to advance the study and application of forensic science. With this aim in view, a series of symposia, to be held alternately in London and in the provinces, is being arranged. Among the subjects suggested for discussion are blood, hypoglycemia, street accidents, and instrumentation.

All persons professionally interested in forensic science are eligible for membership. The president of the society is J. B. Firth, and the secretary is Dr. E. G. C. Clarke of the Royal Veterinary College, London N.W.1, from whom further information may be obtained.

* * *

Natural History, published by the American Museum of Natural History in New York, and *Nature Magazine*, published in Washington by the American Nature Association, have consolidated and will appear in merged form in January. The new magazine will be under the direction of John Purcell, editor of *Natural History*, and will be published in New York. Richard W. Westwood, president of the American Nature Association and editor of *Nature Magazine*, will serve as a contributing editor, reporting on developments in the field of conservation as viewed from the nation's capital. Paul M. Tilden, assistant editor of *Nature Magazine*, will be an associate editor of the combined publication.

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At the recent central divisional meeting of the American Psychiatric Association held in Detroit, a plaque was awarded to Wayne State University's department of psychiatry and to the department's main teaching and clinical facility, the department of psychiatry of Detroit Receiving Hospital, for the best scientific exhibit presented at the meeting. The award recipient was selected by representatives of all the midwestern states. The exhibit was on the diagnosis, understanding, and treatment of emergency psychiatric problems.

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Cornell University has announced the establishment of what is probably the first large university-sponsored center for radiophysics and space research. Thomas Gold has been selected director of the new unit, to be known as the Cornell University Center for Radiophysics and Space Research, and Henry G. Booker is associate director. Gold is professor of astronomy, professor of electrical engineering and professor of physics at Cornell, and Booker is director of the School of Electrical Engineering, professor of engineering physics, and professor of physics.

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The Optical Society of America has established an executive office at 1155 16th St., NW, Washington, D.C. Mary Warga, professor of physics at the University of Pittsburgh, is the executive secretary of the society, which is building up a library in its new office.

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The Commission on Crystallographic Apparatus of the International Union of Crystallography has published a second edition of the *Index of Crystallographic Supplies*, which can be obtained for $2.50 from the Société française de Minéralogie et de Cristallographie, 1, rue Victor-Cousin, Paris 5°, France. The 125-page volume contains a list of equipment and supplies, literature references, advertisements, and addresses of manufacturers and suppliers, including branches in various countries. Chairman of the commission is W. Parrish, Philips Laboratories, Irvington-on-Hudson, N.Y.

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A Symposium on Theory, Technique, and Clinical Application of Vectorcardiography was held at the Medical Academy, Wroclaw, Poland, 21–24 October, under the chairmanship of Hugon Kowarzyk. Outstanding Polish cardiologists, including Professor Zdzislaw Askanas, participated. Papers were presented by scientists from nine European countries, the U.S., and Mexico.

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A comparative study of technical and scientific manpower in 55 countries is the subject of *Training of Technical and Scientific Personnel*, published recently by the United Nations Educational, Scientific, and Cultural Organization. The survey analyzes past experience, present trends, and future possibilities existing in technical-training fields and points out the need for additional teachers. The volume may be obtained from the UNESCO Publications Center, 801 Third Ave., New York, N.Y., or from the Columbia University Press, 2960 Broadway, New York, N.Y.

National Wildlife Week will be observed from 20 to 26 March 1960 under the sponsorship of the National Wildlife Federation and its affiliates in 49 states and the District of Columbia. Walt Disney will serve as honorary chairman for the observance, which will have the theme "Water—Key to Your Survival."

Scientists in the News

Ira V. Hiscock, a leading figure in public health, will retire 1 January as chairman of the public health department at Yale University. He has been on the Yale faculty for 39 years. His retirement has been moved ahead to permit him to become a Carnegie visiting professor in public health at the University of Hawaii for 6 months. He was president of the American Public Health Association in 1956–57 and is a past president of the National Heart Council. He is a member of the expert panel on public health administration of the World Health Organization of the United Nations.

Robert G. Snider has been appointed coordinator of U.S. and international activities in connection with the forthcoming multi-nation oceanographic expedition to the Indian Ocean. He is president of International Population Research, Inc., and chairman of the panel on ocean resources of the committee on oceanography of the National Academy of Sciences–National Research Council.

C. J. Van Slyke, deputy director of the National Institutes of Health, has retired after 30 years' service in the Public Health Service. His work at the National Institutes included the organization and administration of Public Health Service programs in support of medical and biological research.

Van Slyke entered the commissioned corps of the Public Health Service in 1928, after graduating with a medical degree from the University of Minnesota. He was appointed director of the National Heart Institute upon its establishment in August 1948. In December 1952 he was named associate director of the National Institutes of Health and in 1958 was made deputy director.

Arthur C. Cope, head of the department of chemistry at Massachusetts Institute of Technology, has been chosen president-elect of the American Chemical Society. President for 1960 will be **Albert L. Elder**, director of research of the Corn Products Company, Argo, Ill., who takes office on 1 January, succeeding **John C. Bailar, Jr.**, professor of inorganic chemistry at the University of Illinois.

Sylvio Fróes Abreu, director of the National Technical Institute, Rio de Janeiro, and **W. D. Johnston, Jr.,** of the Foreign Geology Branch, U.S. Geological Survey, Washington, were awarded the Vosé Bonifácio de Andrade e Silva Medal of the Sociedade Brasileira de Geologia at the 13th Brazilian Geological Congress, held in São Paulo in November.

J. D. Fulton, National Institute for Medical Research, England, will attend the 16th Annual Conference of the Bureau of Biological Research, to be held at Rutgers University, 29–30 January 1960.

J. A. Loraine, member of the Medical Research Council's Clinical Endocrinology Research Unit, Edinburgh, Scotland, is visiting this country and Canada until 11 January. His itinerary includes New York; Durham, N.C.; Atlanta; Gatlinburg, Tenn.; New Orleans; Salt Lake City; San Francisco; Los Angeles; Detroit; Montreal; and Boston.

Another visitor from abroad is **D. F. Meigh**, principal scientific officer of the Ditton Laboratory of the British Agricultural Research Council. He will be in the United States until mid-February, visiting Washington; Beltsville, Md.; Philadelphia; Boston; the San Francisco area, including Davis, Berkeley, and Albany; the Los Angeles area; Geneva, N.Y.; Ithaca, N.Y.; New York City; and possibly Ottawa, Canada.

Air Force major general **Don R. Ostrander**, now deputy director of the Advanced Research Projects Agency, will head a new unit for rocket-vehicle development at the National Aeronautics and Space Administration. He will join NASA about 1 January as director of launch vehicle programs.

Harold D. Green, professor of physiology and pharmacology at the Bowman Gray School of Medicine, has received a special award from the American Heart Association for distinguished service to research. The award reflects a recently established Heart Association policy to recognize people who have served on the AHA Research Committee for five terms.

Edward D. Amstutz, professor of organic chemistry at Lehigh University, has been named head of the department of chemistry at Lehigh, effective 1 January. He succeeds **Earl J. Serfass**, who has resigned to accept a position as a member of the board of directors and vice-president in charge of research and development of the Milton Roy Company, Philadelphia.

The Institute of Radio Engineers has announced the appointment of **Albert H. Rubenstein**, professor of industrial engineering at Northwestern University, as editor of the *IRE Transactions on Engineering Management*. He is interested in obtaining papers resulting from systematic studies of research, development, and engineering. The range of subjects covered by the *Transactions* includes economic, organizational, and human-relations aspects of these activities. Manuscripts and inquiries should be addressed to the editor at the Technological Institute, Northwestern University, Evanston, Ill.

Frederick J. Brady, former chief program officer, Bureau of State Services, U.S. Public Health Service, has been appointed assistant director of the International Cooperation Administration's Office of Public Health. He succeeds **Charles L. Williams, Jr.,** who has assumed the duties of chief of the Health Division, Lima, Peru.

Sidney Chapman, former international head of the International Geophysical Year, has been appointed to serve until 20 February as senior research scientist at the University of Michigan's Institute of Science and Technology. In this capacity he will lecture and consult with engineers and scientists on appropriate research activities. He has also been selected to present the commencement address at the university's mid-year commencement exercises on 16 January.

Chapman is known for his work as a solar-terrestrial physicist and has been a professor of geophysics at the University of Alaska since 1951. Since 1955 he has been a member of the research staff of the High Altitude Observatory, Boulder, Colo.

Merrill S. Read, chief of the Irradiated Food Branch, U.S. Army Medical Research and Nutrition Laboratory, Denver, Colo., has taken a leave of absence in order to accept a position as visiting professor in the department of biochemistry and nutrition, Virginia Polytechnic Institute, Blacksburg, Va.

Hermann O. L. Fischer, professor emeritus of biochemistry at the University of California, Berkeley, recently received an honorary doctor of sciences degree from the Justus Liebig University in Giessen, Germany, in recognition of pioneering work in the field of biologically important carbohydrates and fats. Fischer has contributed to the development of the modern fermentation scheme, has shed new light on the problem of the formation of hydroaromatic and aromatic compounds from carbohydrates in plant life, and has developed novel methods for lengthening and shortening the carbon chain of sugar molecules.

Chester B. Watts, who retired from active duty at the U.S. Naval Observatory on 30 September, has been appointed research associate at Yale University. He is working on the concluding stages of a survey of the marginal zone of the moon.

Book Reviews

Germany Rejoins the Powers. Mass opinion, interest groups, and elites in contemporary German foreign policy. Karl W. Deutsch and Lewis J. Edinger. Stanford University Press, Stanford, Calif., 1959. xvi + 320 pp. $6.50.

There has been much talk about the German *Wirtschaftswunder*, the remarkable economic recovery of Germany after World War II—and an extraordinary story it has been. Yet in some ways the economic recovery has not been the most impressive of the many German postwar "miracles." After all, we knew long ago that the Germans are hard-working, technically advanced people, and shrewd dealers in international trade. Nor has German recovery, for all the publicity, been so much more rapid than that of other European countries. What is certainly more remarkable than Germany's economic resurgence is its postwar politics; one has better reason to speak of a German *Regierungswunder*, a governmental miracle, than of a German economic miracle.

The prewar German democratic system, the Weimar Republic, was characterized by great instability of governments and by weak coalitions; its governments were almost always inadequate, sometimes impotent, and, in the last stages of the regime, completely paralyzed in the face of mortal economic and political crisis. In 14 years, 20 governments came and went; 11 governed for 8 of the 14 years, supported only by a minority in the Reichstag; those supported by a majority were little better than the minority governments, for all were weak coalitions, always on the verge of fission; minor, inexperienced politicians were constantly pushed to the highest positions in the unending game of coalition-making: men like Luther, Cuno, Brüning, von Papen, von Schleicher. Underlying this state of affairs, and responsible for it, was a hyperpluralistic party system, a low capacity for political integration, either in or out of Parliament, and an utter absence of *Koalitionsfähigkeit*—"coalitionability," to translate very literally. And responsible for this, in turn, was the close identification of parties with vested interests (every major part of the lobby appeared to have a party of its own), the dogmatic and intransigent ideologies of the parties, and the close control of parliamentary politicians by party bureaucrats, hampering their freedom of movement on the parliamentary scene.

Only against this background can we appreciate the magnitude of the governmental miracle since World War II. Old students of German politics must indeed find this a topsy-turvey world. In place of unstable governments, there now is a government which seems almost impervious to change; in place of coalitions, a single party is dominant; in place of party pluralism, there is a virtual two-party system, with Christian Democrats at one pole and the Social Democrats at the other. Instead of the identification of parties with particular vested interests (for example, trade unions, farmers, churches, regions), we find parties making very broad appeals, as do British and American parties. Ideology is on the wane—witness the dropping by the Social Democrat Party of its theoretical Marxism. The party bureaucrats seem to be the puppets of the parliamentarians, not vice versa.

What has happened? And will it last?

Karl Deutsch and Lewis Edinger, in *Germany Rejoins the Powers*, shed considerable light on these questions, although this was not their principal purpose. Their intention, essentially, was to analyze how German foreign policy is made and, incidentially, to assess the reliability of Germany as an American ally, and the various policies we might follow toward her. But they have discharged these limited tasks in such a way that their analysis is relevant to much more than an understanding of the formulation of German foreign policy. It is suggestive in regard to all phases of German political life and is, for this reason alone, a vindication of the modern method of political analysis they have chosen to employ.

This method differs from (or, better, goes beyond) the traditional methods of political analysis in that emphasis is placed not only upon political machinery but upon the whole setting in which the machinery operates: the more general "behavior" patterns (the quotation marks are used advisedly) of which governmental institutions are, at most, a part. For Deutsch and Edinger, five elements play a role in the formulation of foreign policy: the machinery of government itself, the "people" (public opinion, real or imagined), the policy-formulating "elite," the parties, and the interest groups. And in addition to the interplay between these elements, policy is treated as a product not merely of specific deliberative processes but also of general political attitudes, personality types, and the "national character."

This complicated approach to the analysis of foreign policy the authors call (somewhat mysteriously, and I think with little regard for usage) a "functional" approach; the simpler, more formalistic approach which they seek to transcend they call (still more mysteriously) the "descriptive" approach to politics. We may take it that "functional" analysis in this case means nothing more abstruse than a due regard for all the major factors, especially the background material, bearing on a case. But it is precisely this attention to the background (as revealed in public-opinion polls, elite inventories, quantitative studies of social structures, and historical analysis) which makes this work so useful for so many purposes. To be sure, the materials are somewhat outdated (no use seems to be made of polls conducted after 1956), but very little of the German political background seems to have changed significantly in the meantime.

What light, then, does the book shed upon the governmental miracle of the postwar years?

For one thing, it would seem that the present good behavior of the Germans is not unprecedented, but simply one aspect of two persistent themes in German history: on one side, cozy hominess, diligent craftsmanship, stolid competence, finely attuned esthetic and scientific sensibilities; on the other, admiration for force and cunning, hostility toward the outside world, mixed feelings of inferiority and superiority,

glorification of war, romantic daring. This ambivalence of character is reflected in appraisals of the Germans since the 16th century. Foreign observers were at one time impressed by the Germans' lack of discipline and their deficiency in soldierly courage; at another, by their obedience and their robust militarism. We get a very vivid picture of these Jekyll-and-Hyde-like paradoxes (which the authors rightly attribute to the conflicting influences of German history) from the first chapter —at once the most sprightly and the most disorganized, suggestive, and inconclusive of the study.

Germany's past, in Hans Speier's words, has been "truly unresolved." Have we any reason to think that the Adenauer era has resolved it? Unfortunately, the evidence is not all reassuring.

One piece of disquieting evidence is historical; the Germans have, in the past, changed from one aspect to the other of their "character" with fantastic rapidity, precisely because in any existing German behavior pattern its opposite seems always to be latent; the dialectic was a German invention, and Germany is a kind of antithetical country. The Weimar Republic itself is the best example. In 1928, even in 1930, all seemed plain sailing; only 12 Nazis were in the Reichstag, and the moderate Weimar coalition seemed firmly in control. By 1932 the worst had happened: 230 Nazis in the Reichstag, von Papen, representing only a tiny minority, in power, and Hitler waiting confidently in the wings. A year after that, rampant dictatorship. Why should not the same thing happen again?

Every piece of evidence Deutsch and Edinger produce which bears upon this question is itself highly ambiguous—as one might expect. Are the Germans, for example, sufficiently converted to democracy? Public opinion polls show only a steady 25 percent or so fully committed to popular government ("all-weather democrats," the authors call them), despite the fact that 50 percent associate dictatorship with acts of violence. The encouraging thing about these figures is that the young seem more strongly committed to democracy than the old, and that the proportion of reliable democrats seems to be climbing slowly (very slowly). The discouraging thing is that the proportion fully converted to democracy is so low, even after the catastrophic failures and misdeeds of Nazism, and that the proportion of Nazi die-hards seems to be nearly as great. About one-fourth of all Germans hold favorable opinions of Hitler, Hess, and von Schirach, oppose the democratic flag, and even think that no one who resisted in the war should be allowed to hold a high government position now. About a third are "unequivocally anti-Semitic," and a larger proportion still are anti-Semitic in one way or another. A very large number of Germans reproduce in their personal politics the ambivalence of their country, and the ambivalents and the unconverted Nazis constitute a large majority.

One gets an impression, here, of a peculiar disjunction between Germany on the level of government and politics and Germany on the level of public opinion—a disjunction which might well explain the present "governmental miracle" and make doubtful its ability to last. The government, through its restitution policies, has been quite generous to victims of persecutions and has done a good deal to suppress anti-Semitism. The vote for the extremist parties has been reassuringly low. But the Adenauer government seems often to govern merely without the active opposition of the public—not even with its tacit support. Only 11 percent of the public, for example, approved the $700 million indemnity paid to Israel, and similar discrepancies of policies and opinions have occurred in other instances. Is there not latent in this disjunction the possibility of yet another switch of character? One remembers all too well in this connection the sudden intervention in the elections of the early 1930's of those who had previously been apathetic (or aloof) toward politics, and the catastrophe they brought about. Do not these latent extremists still exist?

And what supports Adenauer's government? What gives it such autonomy? Is it the sort of democratic willingness to be led by responsible leaders one finds in Britain, or is it perhaps the admiration Germans still have for the successful autocrat, regardless of the basis of his autocracy? Adenauer is certainly an autocrat (although his power rests upon his party) and, so far, a successful one. And the Germans (over 80 percent of them) certainly appear still to have fond memories of autocracy. Apart from those who hold favorable opinions of many former Nazi leaders, the proportion of Germans who think they were better off before World War II (41 percent) is larger than the proportion who think they were worse off (24 percent)—despite the economic miracle. The Hohenzollerns are remembered with nostalgia (45 percent think the empire was the period when Germany was "best off"), and Bismarck is by far the most popular of all political figures. From this one may at least begin to suspect that the parliamentary system is tolerated—"supported" is much too strong a term—chiefly for its manifest success; but no democratic system is really safe if it cannot count upon unconditional loyalty—that is, if its life depends upon a constant flow of "miracles."

We may be more reassured by the formal machinery of government than by the character of German opinion. The Bonn constitution-makers had Weimar constantly before their eyes and were resolved to prevent a recurrence of its diseases. Their opinions about causes differed, as did those of the Allies with whom they had to negotiate, but in the end they came up with an impressive formal document. On one hand, the constitution was designed to prevent a recurrence of weak prime ministers and of ministerial instability (chiefly through the "constructive" vote of confidence). On the other, it was to prevent, also, the sort of constitutional autocracy (government according to the letter of the constitution but against its spirit) exercised by von Papen, von Schleicher, and Hitler himself—chiefly by the redefinition of emergency powers and the power of dissolution, and through the creation of a special constitutional court. All this, however, is empty formal machinery and, due to party-political conditions, is as yet untested. We do not know how the machinery would work if political life were to become more pluralized; after all, the Weimar constitution was itself proclaimed, in its own day, the best of democratic constitutions. And offices do not operate themselves; we must look at the occupants and at the men who influence them.

Here, once more, the picture is ambivalent in the extreme. It is encouraging to learn that the higher party elite of the Christian Democratic Union, the party in power, has a strong anti-Nazi record; 39 percent have a clear anti-Nazi record (35 percent were imprisoned by the Nazis), and only 4 percent had served the Nazis in official capacities. The anti-Nazi record of the Social Democrats is, of course, greater

still. But it is not encouraging to learn that the record of anti-Nazism falls off sharply below the top levels of the party elite; that cabinet ministers have been far less anti-Nazi than party hierarchs (20 percent belonged to the Nazi party or its affiliates, only 15 percent were imprisoned by the Nazis, and not a single cabinet member went into exile!); that members of the legislature had only a slightly better anti-Nazi record than ministers; and that higher civil servants, diplomats, and military men largely served loyally under Hitler and date back to the latter days of the Empire. This is not encouraging—first, because it means that as the top party leaders die off and are replaced, those most compromised (and presumably molded) by Nazism will achieve power; second, because any decline in the political influence of parties —any less duolithic party system—will mean a decline in power for the more reliable democrats. All the more is this the case when one takes into account the relatively poor anti-Nazi records of the leaders of interest groups (with the possible exceptions of trade-union officials and higher Protestant clergymen) and the still poorer records of leading German educators. Only the elite of the press, among the "influential" outside party politics have a strong anti-Nazi record. The press, of course, plays a large role in forming the foreign image of any country, and it is sobering to realize that the press of Germany is highly atypical of the general public and of the influential (and apparently not particularly able to influence either group). What is more, a relatively large proportion of the higher journalists have proved anti-Nazi records simply because it was the Allies who licensed editors and publishers until 1949; since then the figures have shifted considerably toward those for other elite groups, though they are still rather encouraging (42 percent were clearly anti-Nazi, 37 percent were persecuted).

There is, of course, much more to Deutsch and Edinger's book than I have even intimated; above all, I have omitted their interesting analyses of several cases of actual policy formulation; and while my concerns here have been with the specific political complexion of German opinion and German elite, their concerns are much broader. But if we restrict ourselves to the specifically political, what emerges from their book is this: a country with two shockingly disparate political faces, a reliably democratic party hierarchy disjointed from a largely antidemocratic or uncommitted country; a press largely unrepresentative of opinion; a generation more corrupted by Nazism than its predecessors now coming to power; a still younger generation less corrupted by autocracy than either; and a gnawing doubt: is it wise to rely as much as we do upon a country with a past and a future still so largely unresolved?

But what could one expect of Germany except what she is? In the words of the authors: "How tempting to pretend that all could be forgotten—that a poker-faced generation of amnesia cases could build a new German future by spreading clean wallpaper over the family closets that contain too many skeletons. Indeed, they can be found—the smooth and evasive men of affairs, the elite members with the large gaps in their biographies—but how could they themselves forget what has happened?"

HARRY ECKSTEIN
Center of International Studies, Princeton University

Directory of Nuclear Reactors. vol. 1, *Power Reactors*. International Atomic Energy Agency, Vienna, Austria, 1959 (order from International Publications, 801 Third Ave., New York). 214 pp. Illus. Paper, $3.50.

Sterling Cole, director general of the International Atomic Energy Agency, states in the foreword of this volume that it represents "one of the Agency's first major scientific publications, demonstrating the importance we attach to making data in this field readily available internationally."

The power reactor *Directory* is to be followed by volumes covering reactors in different categories and by supplements which will keep the volumes up-to-date and complete.

This volume provides summary design information about 36 nuclear power stations in nine different countries. Each station has an electrical output of at least 2 megawatts and is either now in operation or scheduled to be in operation by the end of 1962.

The format of the volume is described well by the following paragraph from the introduction:

"Information is presented in a uniform way for each reactor. Thus, the first page contains general information, reactor physics data and information on the core. The second and third pages provide sketches of the fuel elements or of the fuel element assembly and of the horizontal and vertical sections of the reactor. On the fourth page information is grouped under the following headings: fuel element, core heat transfer, control, reactor vessel and overall dimensions, and fluid flow. The fifth page shows a simplified flow diagram and the sixth page provides information on reflector and shielding, containment and turbo-generator; when available, information is given on cost estimates and operating staff. The description of each reactor ends with general remarks and bibliographical data."

This uniform presentation of information gathered from international sources makes the *Directory* a valuable reference document. The format used is logical, legible, and reasonably complete. Unfortunately, no single format is the best one for all types of reactors, so the reader may find some design features of interest omitted or inadequately covered for clear understanding. In most cases, the reader is provided with a bibliography to guide more detailed investigations.

While there are relatively few places (considering the nature of the volume) where information has been listed as "not available," I hope that future supplements will reduce this number still further.

U. M. STAEBLER
Division of Reactor Development, U.S. Atomic Energy Commission

A Bibliography of Birds. With special reference to anatomy, behavior, biochemistry, embryology, pathology, physiology, genetics, ecology, aviculture, economic ornithology, poultry culture, evolution, and related subjects. Part 4, *Finding Index* (to the subject index). Ruben Myron Strong. Chicago Natural History Museum, Chicago, Ill., 1959. 185 pp. $2.75.

The first three parts of this monumental, bibliographic compendium were issued during the years 1939 to 1946. These parts were reviewed in *Science* [**106**, 71 (1947)] by the late E. W. Gudger, who concluded his review with the following comment on Part 3, the subject index. "One has to work over the Subject Index, however, to realize its thoroughness and its complexity. So

great are these things that an alphabetical Finding Index is a necessary key for unlocking the door to the great wealth of the vast and complicated Subject Index. Such an index, now in preparation, is to be published as Part 4. When this has been accomplished and the treasures of this great work made easily available, it will be seen that this is surely *the* Bibliography of Birds, the most valuable tool ever forged for students of ornithology and an imperishable monument to the labors of the author."

Now the final part is before us, and all that need be said is that it fully lives up to Gudger's wish, and that it does make the contents of this whole work readily available. It is a pity that so long an interval separated its appearance from that of the earlier parts. This is no fault of the book or of its author, and it seems better to be glad that the work has been completed than to complain about its delay.

The advances made in all branches of avian biology since the first two parts, the Author Index, were published (1939) have been so great that this index must, of necessity, be used only for what it is—an index of the literature up to 1939. No one should assume from its publication date (1959) that it attempts to cover more recent material.

All students of avian biology will have reason to be grateful to Strong for a most useful work, a work of a sort that demands prolonged and self-sacrificing labors on the part of the compiler, for which he seldom, if ever, is thanked by the people he helps.

HERBERT FRIEDMANN
U.S. National Museum

Anatomy of the Human Body. Henry Gray. Twenty-seventh edition edited by Charles Mayo Goss, Lea and Febiger, Philadelphia, Pa., ed. 27, 1959. 1458 pp. Illus. $17.50.

The only major changes noted in the new edition are in the chapters on the central nervous system and the cardiovascular system. The former chapter has been completely rewritten in a simpler form and shortened by 50 pages. The structural features of the nervous system are emphasized, but the functional aspects are implied. Although the spinal cord is listed as a separate subdivision in the text, there is no corresponding subdivision or introductory paragraph on the brain as a whole.

The chapter on the cardiovascular system has been divided into separate sections on the heart, arteries, and veins. Each section includes a discussion of embryological development. The section on the heart contains an account of the development of the heart, the peculiarities of the fetal vascular system, the external appearance and shape of the heart and pericardium, and a detailed description of the gross anatomy of the heart. There are 26 new illustrations of the embryology and gross anatomy of the adult heart, six new ones of the arteries, and two of the histology of blood vessels. Statistical data on variations in the arteries of the upper abdomen are included.

In the chapter on osteology there are three new illustrations of developing bone. There are also a few new illustrations in the chapters on myology, the nervous system, the skin, and the digestive system. The majority of the new illustrations are from Rauber-Kopsch, *Lehrbuch und Atlas der Anatomie des Menschen*, and several are in color. A discussion of the histology of all the connective tissues has been added to that on bone, while the histology of blood vessels is included in the section on the veins.

The old terminology, rather than the "Nomina Anatomica," officially adopted at Paris in 1955, is still used in many places.

Except for the changes noted above, this edition, published to celebrate the centennial of the first American edition of Gray's *Anatomy*, is not very different from the preceding one. The changes that have been made are improvements over the 26th edition but, unfortunately, these changes are not as extensive as the publisher's notices of the book lead one to expect. However, the editor should not be too strongly criticized for this, since it is well known that publishers are often unwilling to make the revisions in a new edition as extensive as the editor would like.

The book is well bound and printed on high-quality paper, with good clear type and illustrations. The uncomplicated style with relatively short sentences, characteristic of earlier editions, has been retained. These features should ensure Gray's *Anatomy* continued success and popularity with medical and other students.

F. GAYNOR EVANS
Department of Anatomy,
University of Michigan

New Books

Albert Jan Kluyver. His life and work. Biographical memoranda, selected papers, bibliography, and addenda. North-Holland, Amsterdam; Interscience, New York, 1959. 582 pp.

Astrophysique Générale. J. C. Pecker and E. Schatzman. Masson, Paris, 1959. 766 pp. Paper, F. 12,000; cloth F. 13,000.

Australian Atomic Energy Symposium, 1958. Published for the Australian Atomic Energy Commission by Melbourne Univ. Press; Cambridge Univ. Press, New York, 1959. 799 pp. $17.50. This volume is the report of the symposium on the peaceful uses of atomic energy held by the Australian Atomic Energy Commission in Sydney from 2–6 June 1958. The papers cover a wide range of interest related to raw materials, nuclear power, nuclear research, the basic sciences, education, and the industrial and medical uses of isotopes. Contributions to the discussion are included in the volume. The symposium was attended by 435 people; this included 38 participants from overseas.

Fermente. Hormone, vitamine. vol 1, *Fermente.* R. Ammon and K. Myrbäck. Thieme, Stuttgart, Germany, 1959 (order from Intercontinental Medical Book Corp., New York 16). 584 pp. $22.85.

Photoperiodism and Related Phenomena in Plants and Animals. A symposium. Publ. No. 55. Robert B. Withrow, Ed. American Assoc. for the Advancement of Science, Washington 5, 1959. 920 pp. Prepaid to members, $12.50; others, $14.75.

Planetaria and Their Use for Education. Cranbrook Inst. of Science, Bloomfield Hills, Mich., 1959. 205 pp.

Plant Physiology. A treatise. vol. 2. *Plants in Relation to Water and Solutes.* Academic Press, New York, 1959. 775 pp. $22.

A Short History of Scientific Ideas to 1900. Charles Singer. Oxford Univ. Press, New York, 1959. 545 pp. $8.

Standard Handbook for Telescope Making. N. E. Howard. Crowell, New York, 1959. 336 pp. $5.95.

Sugar Cane and Its Diseases. Claude W. Edgerton. Louisiana State Univ. Press, Baton Rouge, ed. 2, 1959. 311 pp. $7.50.

World Weather Records, 1941–50. Weather Bureau, U.S. Dept. of Commerce, Washington, D.C., 1959 (order from Supt. of Documents, GPO, Washington 25). 1361 pp. $4.75. This volume is a continuation of three earlier volumes published in the *Smithsonian Miscellaneous Collections* and records the monthly mean station pressure, mean temperature, total precipitation, and mean sea level pressure for all stations listed in the previous volumes, as well as long homogeneous records for some stations not listed in the earlier volumes. Most of the data were supplied by national meteorological services. The stations are arranged under 12 major divisions—such as Africa, North Atlantic—and by countries or political divisions (in alphabetical order) within the major divisions. The data are arranged by stations alphabetically within countries. Lake, river, and ice data are grouped in separate sections following the meteorological data.

Reports

Peculiar Feeding of Amphiuma under Conditions of Enforced Starvation

Abstract. Two *Amphiuma means* confined in aquaria with flowing artesian water for 3 years, with no known supply of food, increased in size. In the latter part of this period they were observed to shed a sheet of skin by a peculiar process and to devour it. This shed skin contained bacteria of the spirilla type, diatoms, and large amounts of unicellular algae, and possibly other organisms. Similar behavior in unstarved specimens of *Cryptobranchus* confined in an aquarium at the University of Alabama has been observed by E. L. Bishop.

The amphibian family Amphiumidae is confined to the southeastern United States. Only one species, *Amphiuma means*, is recognized. This is the largest amphibian on the North American continent, the maximum known length being slightly less than 40 in. The animal possesses two pairs of widely separated, ineffective legs, which have toes but which nevertheless are little more than relic strands of flesh. The eyes are weak; the body is almost perfectly cylindrical. The animal can progress by an eel-like motion on land, and the eggs are laid there in damp places close to water and guarded by the female, but with this exception life is spent in the water. This more or less helpless creature seems to be special prey of certain snakes. In turn, it is known to feed on crawfish, small fishes, insects, and smaller amphibians. These facts have been derived from many sources, but they have been collated and summarized by Oliver (*1*).

In January 1954 one of us (W.E.B.) placed two *Amphiuma means means* in a 5-quart container with 4.5 quarts of water, with only a small hole through which air could pass. The container was kept in a cool, damp place for 17 months, during which time a small amount of water was added to take care of evaporation. At the end of 17 months the animals were shorter and had decreased both in weight and in diameter. They were still vigorous and showed no signs of weakness when excited. *Siren* has been kept for a year under practically the same conditions, except that the water had to be changed about twice a month; otherwise, it became turbid and the animals died. By the end of the year the animals were reduced in size.

On 17 June 1956 two *Amphiuma means means* were put in separate 15-gallon wooden-and-glass aquaria at the Gulf Coast Research Laboratory, with a continuous flow of hydrant water from an artesian well about 300 feet deep. The smaller animal weighed 402 gm and was 691 mm long. Length and weight measurements were made by one of us (W.E.B.) on the smaller animal for the 3 years between June 1956 and June 1959. Measurements on a third specimen were also made during the last year, June to June. The larger animal was not measured. The data show that the animals increased in length and weight, but we wish to withhold them until we can, if possible, repeat the experiment.

This situation aroused considerable argument because the animals were kept under hardware cloth and copper screen wire and were not fed. A small number of encrusting algae grew on the glass of the aquaria, but this was kept fairly well scrubbed off. In discussion as to how these animals survived and grew, suggestions ranged from intussusception to sneak feeding by parties unknown. The former certainly seems to be most improbable in soft artesian water which contains practically nothing. Sneak feeding is also highly improbable for several reasons. This is a marine laboratory, and no one pays much attention to these fresh-water animals except ourselves. The animals are under observation every day and part of every night, and during the school year very few people are about because teaching is done here only in summer. It is highly improbable that these animals could have been fed enough, without detection, to cause them to increase in size. In fact, one of us (G.G.) once took umbrage at the cruel treatment of these helpless beasts and was strongly inclined, as director of the station, to bring the matter to an end, but strong pleadings and insistence on a continuance on the part of the other prevailed. In any case, we have no knowledge that these animals have ever been fed. We have also considered the matter of pure swelling or water uptake, and it has not been ruled out.

This apparent mystery led to increased attention to the *Amphiuma*, which resulted in a most curious observation. Apparently, about once every 3 or 4 days in the summer, at night, the animal peels a thin film of material from its whole body and then swallows it. The process starts back of the gill slits with a dorsal gas bubble. The film breaks around the body and peels back as the animal swims about, rubbing its sides and stomach until the film forms a roll back of the neck. At this point the animal stops swimming and produces a series of rhythmical, wriggling movements with some peristalsis of the whole body, which causes the film to be rolled posteriorly to the tip of the tail, where it peels off. After this, the animal eats the roll. The process has been observed seven times on three different animals. The gas bubble varies in size. The largest were about 1.5 cm in diameter. When the process proceeds properly the peeled film is doughnut-shaped. Occasionally, however, the process does not proceed properly and the film breaks off and rises to the surface with the gas bubble and with only a thin skein attaching it to the animal. However, when this part reaches the tail, the animal takes it and swallows it all to the end, finally engulfing the larger mass. After "shedding," the *Amphiuma* is no longer sleekly brownish-black in color, but is more grayish. Microscopic examination has shown that the film is a mucin-like material containing epithelial cells and bacteria, plus diatoms and unicellular algae in large numbers. Many of the bacteria are spirilla.

The smallest of the three *Amphiuma* was sacrificed after 1 year without being fed. The digestive tract and liver seemed to be small, but there were dark, loose, watery feces in the cloaca.

This shedding process of *Amphiuma* has been called to the attention of most of the students at this laboratory and of several visitors.

WILLIAM E. BRODE
GORDON GUNTER
Gulf Coast Research Laboratory, Ocean Springs, Mississippi

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Reference

1. J. A. Oliver, *The Natural History of North American Amphibians and Reptiles* (Van Nostrand, New York, 1955), pp. 42, 85, 89, 192, 292.

23 July 1959

Addendum. Since the foregoing report was submitted, there have been some other developments which should be included in this account. On the night of 25 August I noticed that the smaller of the two remaining animals was beginning to shed, with a roll back of its neck. However, this roll did not contain the typical bubble, and apparently the process was not going well. After watching for 1½ hours and seeing no further progress, I left. Next day the animal had the appearance of having shed completely. On 27 August it was found dead. There were no visible causes of death. It was opened at my request by Harry J. Bennett, who has had more experience with the internal organs of *Amphiuma* than anyone else here, because of having searched them for parasites. He thought that the intestine was smaller than usual. The cloaca contained the dark, watery feces noted before. Ovaries were present in a rather flaccid and undeveloped state, but small, yellow, individual ova could be discerned with the naked eye. (This leads to another hypothesis—namely, that the animal could have lived for a very long while on resorbed ovarian material.) The only sign of abnormality was the long urinary bladder greatly distended with liquid. This suggested that possibly the animal had succumbed to some osmoregulatory difficulty. For that reason the larger remaining *Amphiuma* was given a squirt of salt water from the laboratory sea-water system.

On 31 August the larger animal was also found dead. In this instance we have a better idea of the cause of death. Several times these *Amphiuma* had developed little punctate white spots all over the body, which felt hard and calcareous to the touch. They have never been examined microscopically, but we considered them to be fungi. They were controlled by unmeasured doses of potassium permanganate thrown into the water, or by shots of salt water which raised salinity of the aquarium water to 8 per mil; this apparently caused no difficulty to the amphibians. Brode had generally taken care of this matter, and during his absence I apparently let it go too long. The dead animal had a very large atypical swelling in the gill and gular region. It was preserved whole without autopsy. Thus, our observations have, temporarily at least, ended for lack of specimens.

The third development concerns some similar observations on another amphibian. Our colleague in summer teaching, H. T. Boschung, of the department of biology of the University of Alabama, recounted this matter to Everett L. Bishop, Jr., professor of biology at the University of Alabama, who stated that he had made similar observations on *Cryptobranchus*, the hellbender. In a letter to me dated 19 August Bishop stated that two animals were placed in a 75-gallon aquarium on 13 April; the three paragraphs that follow are quoted from his letter.

> In the ensuing months I have placed about 50 live crawfish, ranging from an inch and a half to four inches in length, in the aquarium. Practically all of these have been eaten by the hellbenders. However, no significant increase in size has been noted. During the earlier weeks an almost constant laterally rolling motion took place in both specimens. A guess on my part was that this lateral rolling motion was a reflex associated with the respiratory function of the skin folds. . . .
>
> Almost immediately (12 to 15 hours) after the specimens had been placed in water here a shedding of the skin was observed. Although a major portion peeled away from the head and then slipped off the body, there was some apparent random exfoliation. The shed skin had a distinct yellow-greenish appearance, highly suggestive of green algal pigmentation; although we talked about examining for the algae, we failed to do so. The major portion of the shed skin was 'peeled' off the head by a combination of head movements and rubbing against the bottom and sides of the tank. As this film of skin was rolled back below the pectoral limbs a surprisingly sharp flexion of the head permitted the animal to grasp the skin and peel it rapidly from the remainder of the body, engulfing the free part as it did so. The entire process took only about 10 minutes.
>
> Several of us observed this being repeated four or five times since the original shedding. Unfortunately, no accurate records of observation have been kept. My impressions have been, however, that the sheddings have occurred at greater intervals. No one here can recall seeing this process occur since about the middle of June.

Bishop's observations raise the possibility that exfoliation or ecdysis may be present in other tailed amphibia, and also that it may be supplementary to regular feeding.

GORDON GUNTER

10 September 1959

Rhythmic Contraction of Schwann Cells

Abstract. By time-lapse cinematography it was found that Schwann cells in tissue cultures of dorsal root ganglia from newborn rats show a contraction rate of approximately 4 to 18 minutes. This activity is of the order of magnitude reported for oligodendroglia.

In 1937 Canti, Bland, and Russell (*1*) reported pulsatile activity of cells cultivated from an oligodendroglioma, as revealed by time-lapse cinematography. Employing similar methods, Lumsden and Pomerat (*2*) established that oligodendroglial cells from the corpus callosum of the rat exhibited a contraction-expansion cycle of approximately 5 minutes. These findings were extended to include such elements from presumably nonpathological human tissue obtained in the course of lobotomies (*3*) and from oligodendrocytes of neoplastic origin (*4*). Recent studies of oligodendroglia have been summarized (*5*).

Table 1. Rhythmic contraction of Schwann cells from dorsal root ganglia of newborn rats, in vitro.

Culture*	Days in vitro	No. of contractions	Period (min)	Av. rate (min)
1a†	5	8	70	8.75
1b‡	5	None	95	
1c†	5	8	70	8.75
1d†	6	13	230	17.69
2a†	13	16	151	9.43
2b‡	13	17	113	6.64
2c†	13	70	410	5.85
3a†	13	12	70	5.83
3b§	14	21	80	3.81
3c†	14	16	90	5.62
4a†	16	17	120	7.05
4b†	17	12	70	5.83
4c†	17	1	9	9.00

* Letters indicate sequences providing test cells. † Treatment: nutrient. ‡ Treatment: 50 μg of γ-aminobutyric acid per milliliter of nutrient. § Treatment: 100 μg of γ-aminobutyric acid per milliliter of nutrient.

This report is concerned with the behavior of Schwann cells in tissue culture. Dorsal root ganglia obtained from newborn rats were cultivated under dialysis membranes in Rose chambers (*6*); a fluid nutrient consisting of 50 percent Gey's balanced salt solution, 45 percent human ascitic fluid, and 5 percent horse serum, reinforced with a final concentration of glucose at 300 mg/100 ml, was employed.

Phase-contrast, time-lapse cinematographic film records were made of dorsal root ganglia of rats on four cultures incubated from 5 to 17 days at a rate of four frames per minute. Schwann cells exhibited rhythmic contractile activity closely resembling that of oligodendroglial cells derived from the central nervous system.

Since γ-aminobutyric acid was being employed in parallel studies, this substance was added to some cultures of dorsal root ganglia. Table 1 summarizes observations on the contraction rates of Schwann cells obtained in preliminary experiments. On the basis of this limited series, γ-aminobutyric acid is not believed to have exerted a significant effect on cells in this system, but the data establish the phenomenon of rhythmic pulsatile activity for Schwann cells at a rate approximating that reported for oligodendroglia (*7*).

CHARLES M. POMERAT
Tissue Culture Laboratory, Department of Anatomy, University of Texas Medical Branch, Galveston

References and Notes

1. R. G. Canti, J. O. W. Bland, D. S. Russell, *Research Publs. Assoc. Research Nervous Mental Disease* **16**, 1 (1937).
2. C. E. Lumsden and C. M. Pomerat, *J. Exptl. Cell Research* **2**, 103 (1951).
3. C. M. Pomerat, *J. Nervous Mental Disease* **114**, 430 (1951).
4. ———, *J. Neuropathol. Exptl. Neurol.* **14**, 28 (1955).
5. ———, *Biology of Neuroglia* (Thomas, Springfield, Ill., 1958), p. 162.
6. G. G. Rose, C. M. Pomerat, T. O. Shindler, J. B. Trunnell, *J. Biophys. Biochem. Cytol.* **4**, 761 (1958).

7. Grateful acknowledgement is made to Mrs. Walther Hild and Charles Raiborn for their aid with the preparation of the cultures and to George Lefeber for the photographic work. This investigation was aided by a research grant (PHS B-364 — C5) from the National Institute of Neurological Diseases and Blindness of the National Institutes of Health, U.S. Public Health Service.

7 August 1959

Age of Marginal Wisconsin Drift at Corry, Northwestern Pennsylvania

Abstract. Marl began to accumulate about 14,000 years ago, as determined by radiocarbon dating, in a pond in a kettle hole in Kent drift at Corry, Pa., 9 miles inside the Wisconsin drift margin. This radiocarbon age represents the minimum time since the disappearance of the ice from Corry and confirms an assignment of Cary age to the drift.

Samples of peat and marl from a bog in a kettle hole in the northwestern part of Corry, Pa., have been assayed for C^{14}. Corry, in southeastern Erie County, is 7 miles southeast of the southwestern corner of New York state.

The kettle hole is in a kame complex (*1*), the location of which is well shown on the *Glacial Map of the United States* (*2*), associated with the Kent till (*3*), which is the outermost Wisconsin till of the Grand River glacial lobe in northeastern Ohio and northwestern Pennsylvania. It has been earlier correlated as "early Cary" by White (*4*). The kettle hole is 9 miles northwest of the outer limit of Wisconsin (Kent) drift, which is marked by the prominent 4-mile-wide Kent moraine (*5*).

The kames at Corry are related to the disappearance of the marginal part of the ice sheet, but they may have been deposited at an ice edge which readvanced slightly to Corry after retreat from the Kent moraine. The age of the lowest part of the organic deposits establishes the minimum time since the kettle hole has been available for the accumulation of organic material.

The bog is being worked for peat for floriculture by Russell Graham and Earl Shade, who report that the peat in the center of the bog is as much as 30 ft thick and is everywhere underlain by marl. The section and samples for which data are given in Table 1 were secured in an auger boring; the dating of the samples was done in the radiocarbon laboratory of the U.S. Geological Survey. The apparent difference in age between the highest marl and the lowest peat may be real—that is, no material was deposited for almost 4000 years—or more probably it reflects contamination of the peat sample with peat from higher levels.

The age determination for the lowest marl is consistent with the interpretation of Cary age for the drift at Corry. This is the first determination of the age of drift of northwestern Pennsylvania to be made by means of radiocarbon analysis.

JOHN B. DROSTE
Department of Geology, Indiana University, Bloomington

MEYER RUBIN
United States Geological Survey, Washington, D.C.

GEORGE W. WHITE
Department of Geology, University of Illinois, Urbana

References and Notes

1. The field study of the glacial deposits of this part of northwestern Pennsylvania was made by J. B. Droste as part of the investigation of till composition of the Allegheny Plateau supported by National Science Foundation grants to G. W. White. Publication of this report has been authorized by the director of the U.S. Geological Survey.
2. R. F. Flint, R. B. Colton, R. P. Goldthwait, H. B. Willman, *Glacial Map of the United States . . .*, (Geological Society of America, New York, 1959).
3. G. W. White, J. B. Droste, R. F. Sitler, V. C. Shepps, *Bull. Geol. Soc. Am.* **68**, 1902 (1957); V. C. Shepps, G. W. White, J. B. Droste, R. F. Sitler, *Penn. Geol. Survey Bull. G. No. 32* (1959).
4. G. W. White, *Ohio Div. Water, Bull.* **26**, 37 (1953).
5. ———, *Bull. Geol. Soc. Am.* **68**, 1902 (1957).

28 July 1959

Table 1. Description and radiocarbon dates of samples from an auger boring.

Sample	Ft	In.
Peat, brown to greenish brown, with leaves, grasses, seeds, and wood. Sample W-347 from lowest 8 in., age 9,430 ± 300 years	9	9
Marl, light to medium gray, rich in plant material, highly calcareous, very fossiliferous, contains pelecypods, gastropods, and ostracods. Sample W-346 from top 8 in., age 13,000 ± 300 years; sample W-365 from bottom 8 in., age 14,000 ± 350 years	3	0
Clay, blue gray, silty, laminated, highly calcareous	9	0
Sand and fine gravel, gray, calcareous	1	6
Bottom of auger hole		

Tolerance of Mouse-Brain Tissue to High-Energy Deuterons

Abstract. A striking relationship between the size of the impact area of a deuteron beam and the threshold dose for a radiogenic lesion has been noted. The dose required to produce a threshold lesion in mouse brain increases from 30,000 rad with a beam 1000 μ in diameter to 1.1×10^6 rad with a beam 25 μ in diameter.

The experiments reported here are part of a program designed to investigate the biological effect of heavy cosmic ray primaries upon brain tissue by a simulated technique. This technique is based on the expectation that most of the biological effect of a cosmic ray primary would result from the dense cluster of secondary protons surrounding the path of the primary. It is estimated that such a cluster would create a core of ionization about 25 μ in diameter (*6*). Thus, a beam of protons or deuterons of a certain dose and about 25 μ in diameter should simulate to a certain extent the spatial pattern of ionization energy of the thindown of a heavy cosmic primary. On the other hand, by this technique one is unable to approximate the dose rate of a cosmic primary, which transfers its energy within a billionth of a second. However, preliminary studies indicate that, with a 25-μ beam, an increase in the dose rate from 15,000 to 400,000 rad/sec decreases the threshold dose for a radiogenic lesion only by approximately 10 to 20 percent. This suggests that the differences in dose rates between cosmic primaries and the simulating techniques may be of minor biological significance.

The phase of the study reported here is concerned only with the independent variable of beam size.

The irradiations were performed with a 22.5 Mev deuteron beam from the 60-in. cyclotron at the Brookhaven National Laboratory. After passing through a helium ionization chamber and 2 in. of air, the beam had a depth range in tissue of approximately 2.5 mm. Dosimetry was based on continuous recording of the current in the ionization chamber. The mean dose rate varied from 15,000 to 60,000 rad/sec. Density measurements on phantoms consisting of laminated photographic films distal to the apertures were used to calculate dose distributions. The dose in rad was calculated from the total number of deuterons absorbed per unit volume of tissue, and this calculation was confirmed, to a first approximation, by depth dose measurements with films. The ionization in tissue is quite uniform to a depth of 1.5 mm, and this was the only region considered, since beyond this depth the ionization density in-

creases markedly (Bragg effect) and makes dosage calculation very difficult.

Round apertures with a diameter of 1, 0.075, and 0.025 mm, respectively, in 0.4-mm platinum foil were placed directly in front of the target area to achieve the desired beam profile. After passing the aperture the beam was relatively well collimated to a depth of 1.5 mm, but beyond this scattering broadens the beam considerably for the smaller beam diameters.

One hundred Carworth CF_1 female mice 6 to 7 weeks old and weighing 25 to 32 gm were used. The beam was directed to the exposed skull at a point 1.5 mm to the right of the longitudinal suture and 1.5 mm anterior to the lambda suture. The head was kept in a fixed position by placing the upper front teeth over a bar and inserting two metal pins into the outer auditory meatus on each side. The animals were kept under light Nembutal anesthesia. None of the animals exhibited any abnormal reactions after irradiation.

After 3, 6, 12, 24, and 48 days, respectively, the mice were anesthetized with Nembutal and perfused with Susa fixative. The brains were embedded in paraffin and cut in serial sections at 8μ. The following staining methods were used: gallocyanin, hematoxylin-van Gieson, and PAS-gallocyanin.

With a 1-mm beam, a single exposure with 30,000 rad produced within 12 days a cavitation—that is, complete destruction of all tissue components in the center of the beam. After 24 days the lesion had grown somewhat larger and comprised almost the entire beam path (Fig. 1, *A*). A dose of 60,000 rad produced a larger and more uniformly shaped cavity within 24 days (Fig. 1, *B*). No lesion was observed at 15,000 rad. This means that the threshold for a destructive lesion along the first half of the beam path is between 15,000 and 30,000 rad for a 24-day latency.

With a 0.075-mm beam, a dose of 150,000 rad resulted in complete loss of ganglion cells along the beam path within 6 days. Mice that had survived for 24 days after exposure to the same dose exhibited a similar lesion. With a dose four times higher, the histologic character of the lesions did not change. The tract, however, became somewhat broader, reaching a diameter of 100 μ as compared to one of 70-μ diameter produced by 150,000 rad. With 75,000 rad no lesions developed until the 24th day. It may therefore be concluded that the threshold dose for producing a lesion within 24 days is about 75,000 rad.

To produce a histologic lesion with a beam of 0.025 mm, a dose of 1.1×10^6 rad was required (Fig. 1, *C* and *D*). A dose of 550,000 rad did not result in any histopathologic changes. A dose of 2.2×10^6 rad did not alter the histologic appearance of the lesion, although it widened the tract from 25 to 40 μ. Cavitation have never been observed, even at very high dosages, and this constitutes a striking qualitative difference between these findings and those with the 1-mm beam.

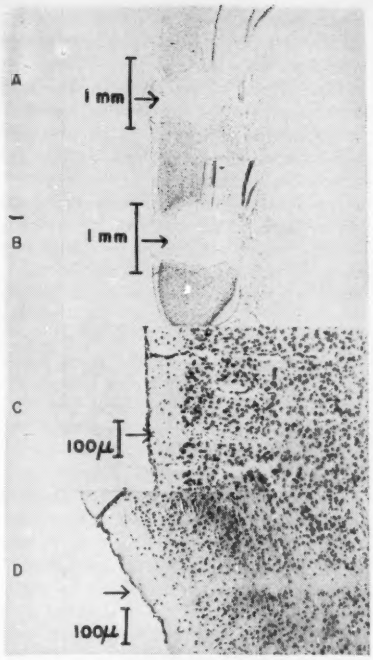

Fig. 1. Frontal sections of visual cortex of mice irradiated with deuteron beams. The arrows indicate the direction of the beam. (A) 1-mm beam, 30,000 rad, 24-day survival; (B) 1-mm beam, 60,000 rad, 24-day survival; (C) 0.025-mm beam, 1.1×10^6 rad, 6-day survival; (D) 0.025-mm beam, 1.1×10^6 rad, 48-day survival.

For production of a histologic lesion 24 days after exposure to deuteron beams of 1.0, 0.075, and 0.025 mm, radiation doses of approximately 25,000, 75,000, and 10^6 rad, respectively, are necessary. These results indicate that there is an inverse relationship for small volumes between radiosensitivity and tissue volume exposed, and that if the beam size were further decreased the sensitivity might be very low indeed.

The decease in sensitivity found for small exposure volumes is quite consistent with the finding of Kereiakes *et al.* (*1*)—that grids with small holes afford more x-ray protection for rats than grids of the same exposure area with large holes. These findings also correlate well with results of Devik (*2*), who used very small wires to shield skin areas, and of Chase (*3*), who exposed skin to small proton and x-ray beams. The basis of this increased tolerance is not well understood; it has been surmised that it results from a protection of the irradiated tissue by its unirradiated surroundings. Another explanation, more appropriate to the experiments described here, would be that the microbeams cause a predominantly direct radiation injury, whereas the large beams produce additional indirect effects. Indeed, the studies of Larsson, Leksell, Rexed, and Sourander (*4*) suggest that in large radiation areas vascular disturbances in the form of plasma exudation, hemorrhages, and edema play an important role in the pathological development of radiogenic lesions of the nervous system. Such factors hardly apply to the lesions produced by microbeams, because vessels are only occasionally located within the beam path, as seen in serial sections. If a length of 1400 mm of capillaries per 1 mm^3 of brain tissue is assumed (*5*), the capillaries would be spaced about 78 μ apart, from outside wall to outside wall. This would theoretically permit even a 75-μ beam to pass through the tissue without hitting a significant number of vessels. Further support for a direct action by the microbeams is derived from the observation that the lesions are sharply delimited and do not follow any vascular distribution pattern.

It would appear from these results that the biological effects of primary cosmic rays may not be as damaging as has been supposed (*6*). These data also have very important implications for basic radiobiology (*7*).

WOLFGANG ZEMAN
Columbus Psychiatric Institute and Hospital, Columbus, Ohio

H. J. CURTIS
E. L. GEBHARD
Biology Department, Brookhaven National Laboratory, Upton, New York

WEBB HAYMAKER
Armed Forces Institute of Pathology, Washington, D.C.

References and Notes

1. J. G. Kereiakes, W. H. Parr, J. R. Storer, A. T. Krebs, *Proc. Soc. Exptl. Biol. Med.* **86**, 153 (1954).
2. F. Devik, *Advances in Radiobiology* (Oliver and Boyd, Edinburgh, 1957), p. 226.
3. H. B. Chase, *J. Aviation Med.* **25**, 388 (1954).
4. B. Larsson, L. Leksell, B. Rexed, P. Sourander, *Acta Radiol.* **51**, 52 (1959).
5. H. S. Dunning and H. G. Wolf, *J. Comp. Neurol.* **67**, 433 (1937).
6. H. J. Schaefer, *J. Aviation Med.* **25**, 388 (1954).
7. This work was carried out partly under the auspices of the U.S. Atomic Energy Commission and partly with funds from USAF project 7851, Aero Medical Field Laboratory, Holoman Air Force Base, N.M. We wish to thank C. P. Baker for invaluable assistance.

13 August 1959

Free-Radical Concentrations and Other Properties of Pile-Irradiated Coals

Abstract. Five coals reacted quite differently when they were exposed to pile-irradiation. Little or no change was found in free-radical content for the three coals of lowest carbon content, whereas the two coals of highest carbon content were found to have a considerable increase in free-radical content. The infrared spectra and the apparent hardness of the irradiated coals of higher carbon content indicate that polymerization occurred. Radiation of these coals in chemical reagents may promote reactivity.

Five coals ranging in rank from lignite to low-volatile bituminous coal have been exposed to radiation from the reactor at Brookhaven National Laboratory (*1*). Small samples (5 gm) of each coal were exposed under vacuum in aluminum cylinders for approximately 120 days to an integrated flux of 2.29×10^{19} slow neutrons per square centimeter. During this period the pile was operated at 24 Mw, the flux at the exposure site was 2.5×10^{12} neutrons per square centimeter per second, and exposure temperature was below 50°C. Irradiation was primarily by slow and fast neutrons with attendant hard beta- and gamma-radiation; presumably gamma-heating of the coals was slight. Data for the coals are shown in Table 1.

Ingram and Uebersfeld and their coworkers (*2*), carried out electron paramagnetic resonance measurements on coals and ascribed their results to the occurrence of free radicals. The irradiated coals have similarly been examined by electron paramagnetic resonance to determine the effects of radiation on their respective free-radical contents. Measurements were made on a conventional Varian EPR spectrometer at a frequency of 9.5×10^3 Mcy/sec with fields of around 3300 gauss. Various microwave power outputs down to 1 mw were used in order to avoid errors due to saturation of the sample.

The effects of radiation on the free-radical content of the low-rank coals—those having less than 83 percent carbon—appear to be negligible under the conditions described. Comparatively large increases in free-radical content were observed for coals of higher rank—those containing 89.3 and 90.5 percent carbon. The structures of these coals are apparently amenable to the formation of permanent free radicals by irradiation. The difference in irradiation effects between the high- and low-rank coals is not explained; there are, however, definite differences in both physical structure and chemical behavior between coals of 90-percent carbon content and coals of lower rank.

Widths of the electron resonance absorption lines can give information on the environment of the free-radical electron or on changes in that environment with irradiation. But no large changes in line width were found as a result of irradiation. The greatest percentage decrease in line width produced by irradiation was found for the 90.5-percent carbon coal, 1.4 to 1.1 gauss (*in vacuo*). In the presence of air the 90.5-percent carbon coal had a line width of 6.0 gauss, presumably because of interaction of molecular oxygen and the free-radical electrons. All other coals showed only slight differences in line width with the presence or absence of air.

Features of infrared spectra of coals have been discussed by Brown (*3*) and by Friedel and Queiser (*4*). Infrared spectra of the irradiated coals (Fig. 1) were more diffuse than those of the unirradiated samples, but the wavelengths and the relative intensities of the absorption bands were unchanged; this finding indicated that no appreciable changes in rank had occurred.

Table 1. Free-radical concentrations and spectral-line widths for coals (*in vacuo*) before and after irradiation. Analytical data given on a moisture- and ash-free basis.

Item	Coal*									
	A		B		C		D		E	
	Orig.	Irrad.	Orig.	Irrad.	Orig.	Irrad.	Orig.	Irrad.	Orig.	Irrad.
Free radicals/gm $\times 10^{18}$	1.2	1.2	3.9	3.7	5.1	4.6	10.1	18.3	14.2	18.7
Line widths (gauss)	6.5	6.6	6.5	6.4	7.8	7.0	1.2	1.2	1.4†	1.1
Ultimate analysis (%)										
Carbon	69.9	69.4	77.8	77.0	82.4	78.4	89.3	86.9	90.5	88.6
Hydrogen	4.5	4.3	4.8	4.5	5.6	5.1	4.9	4.6	4.5	4.4
Nitrogen	1.0		1.7		1.7		1.8		1.3	
Oxygen (difference)	23.9		15.2		9.6		3.4		3.0	
Sulfur	0.7	0.6	0.5	0.6	0.7		0.6	0.6	0.7	0.5
Proximate analysis (%)										
Volatile matter	47.1	43.9	36.1	35.0	39.8	30.3	23.5	22.3	16.6	17.7
Fixed carbon	52.9	56.1	63.9	65.0	60.2	69.7	76.5	77.7	83.4	82.3
Calorific value (Btu/lb)	11,550	11,500	13,320	12,950	14,790	13,770	15,590	15,120	15,620	15,450

*Coals: A, lignite from Dakota Star mine, Mercer County, N.D.; B, subbituminous coal from Washington mine, Weld County, Colo.; C, high-volatile A bituminous coal from No. 3 Elkhorn mine, Breathitt County, Ky.; D, medium-volatile bituminous coal from Garden Ground mine, Fayette County, W. Va.; E, low-volatile bituminous coal from Slab Fork No. 8 mine, Raleigh County, W. Va.
†The line width for this coal in air is 6.0 gauss. No other large changes were observed with irradiation or with the presence of air.

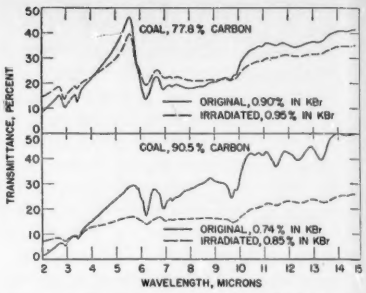

Fig. 1. Infrared spectra of irradiated coals.

The diffuseness of the spectra indicates appreciable polymerization. Radiation had the least effect on the infrared spectra of lignite (69.9 percent carbon) and subbituminous coal (77.8 percent carbon) (Fig. 1); the spectra of the coals of higher rank were more diffuse (Fig. 1, 90.5-percent carbon). As was to be expected, the infrared spectra provided no information on the nature of the free radicals produced by irradiation because these radicals apparently do not affect the vibration spectrum other than by possibly producing some electronic background absorption.

Upon preparing specimens for infrared studies it was noted that the hardness of the coals had changed drastically as a result of irradiation; irradiated coals were much more difficult to grind than unirradiated samples. Although no measurements of hardness were made, it would appear that the polymeric structure of the coals was increased by the radiation; this was also indicated by the infrared absorption spectra. Recent investigations of uranium-bearing coals demonstrated that radiochemical dehydrogenation results from α-particle irradiation and that polymerization probably occurs (*5*).

The increase in free-radical content and the apparent polymerization of the irradiated 90-percent-carbon coals suggest the possibility that these coals are highly reactive with chemical agents after irradiation. When unirradiated coals containing about 80 to 90 percent carbon were treated with lithium ethylamine (*6*) and lithium ethylenediamine (*7*), the coals containing 90 percent carbon had the highest concentrations of free radicals and were the most reactive. This high reactivity was paralleled by the largest decrease in concentration of free radicals. Such reactions may be promoted by radiation *in situ* (*8*).

R. A. FRIEDEL
U.S. Bureau of Mines, Pittsburgh, Pennsylvania
IRVING A. BREGER
U.S. Geological Survey, Washington, D.C.

References and Notes

1. I. A. Breger and E. B. Brittin, preprint, Proc. Natl. Colloid Symposium, Madison, Wis., June 1956.
2. D. J. E. Ingram and J. G. Tapley, *Nature* **174**, 797 (1954); J. Uebersfeld, A. Etienne, J. Combrisson, *ibid.* **174**, 614 (1954).
3. J. K. Brown, *J. Chem. Soc.* **1955**, 744 (1955).
4. R. A. Friedel and J. A. Queiser, *Anal. Chem.* **28**, 22 (1956).
5. I. A. Breger, Proc. 3rd Conf. on the Origin and Constitution of Coal, Crystal Cliffs, Nova Scotia, 1956 (in press); *Bull. Geol. Soc. Am.* **67**, 1675 (1956); S. Ergun, W. F. Donaldson, I. A. Breger, paper presented at the 3rd International Conference on Coal Science, Valkenburg, Netherlands, Apr. 1959.
6. P. H. Given, V. Lupton, M. E. Peover, paper presented at the Conference on Science in the Use of Coal, spring meeting of the Institute of Fuel, 1958; D. E. G. Austen and D. J. E. Ingram, *ibid.*
7. I. Wender, L. Reggel, R. Raymond, preprints, Proc. Gas and Fuel Div., Am. Chem. Soc. (spring 1959).

8. Publication of this report was authorized by the directors of the Bureau of Mines and the Geological Survey, U.S. Department of the Interior. We wish to thank Marvin Fox, J. J. Floyd, and F. Reeve of Brookhaven National Laboratory for assistance with irradiations. Electron paramagnetic resonance spectra were obtained by Gorton Wood. This work was conducted in part by the U.S. Geological Survey on behalf of the Division of Research, U.S. Atomic Energy Commission.

17 June 1959

Selective Phagocytosis of Nucleated Erythrocytes by Cytotoxic Amebae in Cell Culture

Abstract. Strains of *Acanthamoeba*, which produce cellular damage resembling viral cytopathic effect, are known to occur in cultures of monkey kidney cells. Trophozoites of a similar strain were observed to engulf and denucleate chicken erythrocytes. Nonnucleated guinea pig erythrocytes were apparently left unchanged.

Recently two virus research groups (*1*) have reported on the occurrence of amebae of the genus *Acanthamoeba* as natural "contaminants" in monkey kidney cultures. These amebae were cytotoxic, producing cellular damage not unlike viral cytopathic effect. A similar strain of amebae was isolated in our virus laboratory. An accidental observation of the remarkable behavior of these organisms in relation to nucleated and nonnucleated erythrocytes should be recorded as information of possible importance to other investigators.

We isolated the amebae in 1957 from one of the tubes in a large group of rhesus monkey kidney cell cultures which were under observation for visible viral effects. Six days after the replicate monolayer tube cultures were prepared by the usual trypsinization method, this particular tube was inoculated with a routine throat swab specimen from a healthy child who was in contact with a febrile patient under surveillance. Nine days later (the 15th day after trypsinization) early cellular damage was noted near the borders of the sheet. This resembled the cytopathic effect produced by the enteroviruses, although progression of the cellular degeneration was noted to be unusually slow. Serial passages of the culture fluid were made; by the tenth passage the characteristic effect made its appearance on the second day with complete degeneration of the cellular sheet within a week. Although with passage the incubation period was thus markedly shortened, the titer of the culture fluid, using the cytopathic effect endpoint, was maintained at 10^8. Repeated attempts at reisolation from the original human specimen were unsuccessful.

It became apparent that this was not a known enterovirus, and we initiated additional studies. The monkey kidney passaged agent was found to grow well (as evidenced by the appearance of the specific effect) in monolayer cultures of human amnion, chorion, and HeLa cells; the shortest (overnight) incubation period was observed in dog kidney cell cultures. To elucidate further the nature of the presumably viral agent, we attempted the hemadsorption procedure, which at that time was being developed in our laboratory (*2*), on some of the tubes with visible cellular degeneration. Chicken and guinea pig erythrocytes were added to the monkey kidney culture tubes which were examined under low magnification (×150) for the characteristic hemadsorption patterns. We did not find hemadsorption with either type of erythrocyte, but clumping, suggestive of hemagglutination, occurred in the tubes to which chicken erythrocytes were added. The clumping apparently was caused by small round bodies which at first were assumed to be detached renal cells.

The possibility that the agent was a strain of cytotoxic amebae was considered, and we examined the tubes under higher magnification (×795) (*3*). The peripheral portions of the kidney cell sheet were found to contain intracellular and extracellular thick-walled cysts approximately 20 μ in diameter; some of the renal cells contained several cysts crowding the cell nucleus to the side; these bulging cells occasionally ruptured, releasing the cysts into the nutrient fluid which already contained numerous motile trophozoites.

Both types of erythrocytes were then added to hanging drop preparations of culture fluid to study the clumping of erythrocytes. Addition of nonnucleated guinea pig erythrocytes caused little change: the trophozoites showed no visible reaction or merely "palpated" nearby red blood cells with their pseudopodia; an occasional trophozoite engulfed a guinea pig cell but promptly rejected it seemingly unchanged. Addition of nucleated chicken red cells produced the characteristic clumping: the freely moving trophozoites attached to the erythrocytes and engulfed them. After a variable period of time the amebae ejected misshapen, apparently completely *denucleated*, erythrocytes.

Limited attempts at characterization of the pseudo-viral agent disclosed that it was removed completely from the cell culture fluid by filtration (Selas 03), by centrifugation at 2000 rev/min for 30 minutes (International No. 2) and by heating in a water bath at 56°C for 3 hours (although not after 1 or 2 hours). The amebae were preserved in the culture fluid at room temperature for at least 13 weeks; at 37°C for 2 weeks; at 4°C for 7 weeks and at −50°C for 8 weeks. The incubation period, as measured by the appearance of specific cytotoxic changes, was considerably prolonged with storage at lower temperatures.

The amebae were identified by Leon Jacobs as belonging to the genus *Acanthamoeba* (*4*). Our findings provide further evidence that the previous reports (*1*) of the isolation of the *Acanthamoebae* from monkey kidney cultures were more than spurious observations of air contamination of the culture material or of a unique presence of the organisms in certain monkey organs; on the contrary, this might be a common occurrence generally overlooked.

Awareness of these repeated experiences may prompt the virologist who finds unusual cytotoxic effects to consider cytotoxic amebae rather than a bizarre viral agent. The remarkably selective behavior of the trophozoites in denucleating chicken erythrocytes may provide another clue and a tool for investigation of metabolic requirements of artificially propagated amebae.

LOTTA CHI
JOHN E. VOGEL*
ALEXIS SHELOKOV*

National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

References and Notes

1. W. G. Jahnes, H. M. Fullmer, C. P. Li, *Proc. Soc. Exptl. Biol. Med.* **96**, 484 (1957); C. G. Culbertson, J. W. Smith, J. R. Minner, *Science* **127**, 1506 (1958).
2. J. Vogel and A. Shelokov, *Science* **126**, 358 (1957); A. Shelokov, J. Vogel, L. Chi, *Proc. Soc. Exptl. Biol. Med.* **97**, 802 (1958).
3. Oculars (15×) and a special oil immersion lens (53×) by Galileo were used.

4. We wish to thank Dr. Leon Jacobs, chief of the Laboratory of Parasitic Diseases, National Institute of Allergy and Infectious Diseases, NIH, for his assistance in identification of the amebae.

* Present address: Middle America Research Unit, Balboa Heights, Canal Zone.

20 July 1959

Forthcoming Events

January

24–29. American Rocket Soc., Princeton, N.J. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

25–28. Institute of the Aeronautical Sciences, 28th annual, New York, N.Y. (IAS, 2 E. 64 St., New York 21.)

25–28. Plant Maintenance and Engineering Show, Philadelphia, Pa. (R. S. Wolcott, Clapp & Poliak, 341 Madison Ave., New York 17.)

25–29. Stress Measurement Methods, symp., Tempe, Ariz. (P. K. Stein, Strain Gage Readings, 5602 East Monte Rosa, Phoenix, Ariz.)

27–28. College-Industry Conf., Amer. soc. for Engineering Education, St. Louis, Mo. (W. L. Collins, ASED, Univ. of Illinois Urbana.)

27–28. Group Therapist, His Personality, Training, and Functions, 4th annual, AGPA, New York, N.Y. (American Group Psychotherapy Assoc., Inc., 1790 Broadway, New York 19.)

27–29. American Mathematical Soc., 66th annual, Chicago, Ill. (J. W. Green, Univ. of California, Los Angeles 34.)

27–30. American Physical Soc., annual, New York, N.Y. (K. Darrow, APS, Columbia Univ., 116 St. and Broadway, New York.)

28–30. Mathematical Assn. of America, 43rd annual, Chicago, Ill. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

28–30. Western Soc. for Clinical Research, 13th annual, Carmel-by-the-Sea, Calif. (W. N. Valentine, Western Soc. for Clinical Research, Univ. of California Medical Center, Dept. of Medicine, Los Angeles 24.)

29–30. American Group Psychotherapy Assoc., Inc., 17th annual conf., New York, N.Y. (American Group Psychotherapy Assoc., Inc., 1790 Broadway, New York 19.)

29–30. Host Influence on Parasite Physiology, New Brunswick, N.J. (L. A. Stauber, Rutgers Univ., New Brunswick.)

31–5. American Inst. of Electrical Engineers, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

31–7. Pan American Cong. of Ophthalmology, 6th, Caracas, Venezuela. (J. W. McKinney, 921 Exchange Bldg., Memphis, Tenn.)

February

1–4. American Soc. of Heating, Refrigerating and Air Conditioning Engineers, semi-annual, Dallas, Tex. (Miss J. I. Szabo, ASHRACE, 234 Fifth Ave., New York 1.)

1–4. Instrument-Automation Conf., Houston, Tex. (Director, Technical and Educational Services, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

1–5. American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

1–5. Clinical Cong. of Abdominal Surgeons, Miami Beach, Fla. (CCAS, 633 Main St., Melrose 76, Mass.)

2–4. Haemopoiesis—Cell Production and Its Regulation, Ciba Foundation symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

2–4. Society of the Plastics Industry (Reinforced Plastics Div.), Chicago, Ill. (W. C. Bird, SPI, 250 Park Ave., New York 17.)

3–5. Military Electronics, IRE winter conv., Los Angeles, Calif. (G. B. Knoob, Motorola, Inc., Military Electronics Div., 1741 Ivar Ave., Hollywood 28, Calif.)

3–6. American College of Radiology, New Orleans, La. (W. C. Stronach, 20 N. Wacker Dr., Chicago 6.)

3–6. Parathyroid Research, symp., Houston, Tex. (R. V. Talmage, Dept. of Biology, Rice Inst., Houston.)

4–6. American Soc. for Metals, San Francisco, Calif. (R. Huggins, ASM, Stanford Univ., Stanford, Calif.)

4–6. Congress on Administration, 3rd annual, Chicago, Ill. (R. E. Brown, American College of Hospital Administrators, 840 N. Lake Shore Drive, Chicago 11.)

7–10. Radioactive Isotopes in Clinical Medicine and Research, 4th intern. symp., Bad Gastein, Austria. (R. Höfer, 2nd Medical Univ. Clinic, 13 Garnisongasse, Vienna 1X, Austria.)

(See issue of 13 November for comprehensive list)

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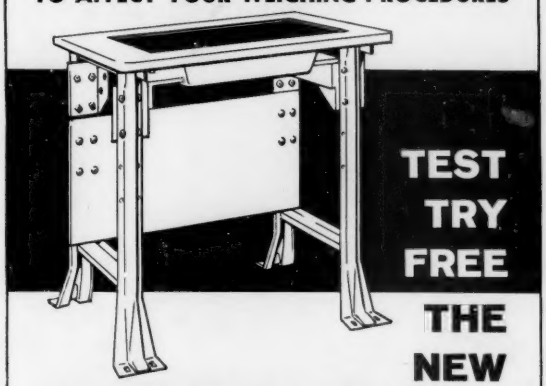

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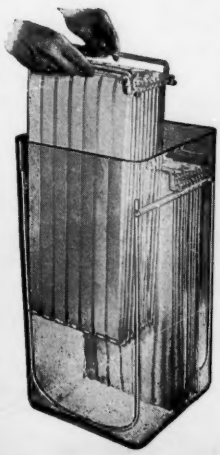

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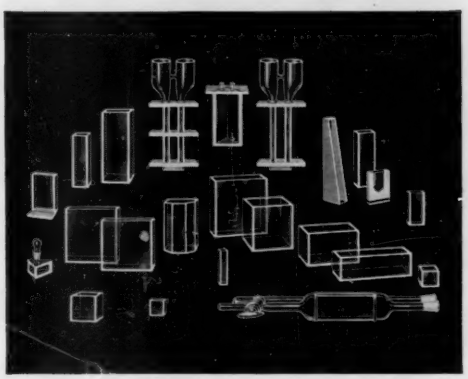

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